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Towards a socio-cognitive perspective of presenteeism, leadership and the rise of robotic Interventions in the workplace.

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PhD in Management, Specialization In Organizational Behavior and Human Resources.

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BUSINESS
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Department of Human Resources and Organizational Behavior

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A presente tese de doutoramento foi feita no âmbito do projeto Digital Talent Ecosystem (DTE) com o código LISBOA-01-0247-FEDER-045216 em curso na empresa Novabase Neotalent SA entre 1 / Setembro /2019 e 31 / Agosto / 2021.

O DTE tem como objetivo principal conceber e desenvolver uma plataforma web integrada, com mercado potencial à escala mundial, que visa digitalizar o mercado de Talento e a interação entre os seus vários intervenientes, nomeadamente Talentos, consumidores de talento, fornecedores de talento e desenvolvedores de talento, que pretendem satisfazer as suas necessidades de oferta e procura de talento.

O DTE pretende disponibilizar um conjunto de funcionalidades inovadoras que recorrem a tecnologias nas áreas da inteligência artificial e *blockchain*, nomeadamente:

- Uma *framework* de seleção e avaliação de candidatos baseada em *Computerized Adaptative Tests* e na Teoria de Resposta ao Item – *Talent Assessment Framework*;
- Um motor de sugestão de Talento baseado em aprendizagem computacional – *Talent Recommendation*;
- Uma ferramenta de recomendação de talentos e equipas a projetos baseado em aprendizagem computacional e algoritmos genéticos – *Team Recommendation*;
- Um motor de sugestões automático para progressão na carreira baseado em aprendizagem computacional – *Career Recommendation*;
- Um sistema de recolha, registo e salvaguarda de conhecimento profissional e eventos de carreira baseado em *blockchain* e *smart contracts* – *Career Logbook*.

Os dados usados no estudo efetuado são referentes a colaboradores da Novabase Neotalent sendo os resultados da investigação efetuada utilizados na construção dos módulos *Talent Assessment Framework* e de *Talent* e *Career Recommendation*.

Para mais informações sobre o projeto, consultar a respetiva ficha de projeto disponível no seguinte *url*: https://content.novabase.com/storage/uploads/dte-fichadeprojeto.pdf

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"Humans shape their life circumstances and the courses their lives take. (...) they are contributors to their life circumstances, not just products of them." Albert Bandura.

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Espero ter deixado todos orgulhosos, e tentarei continuar sempre a dar o meu melhor.

Alis Volat Propriis

RESUMO

A presente tese pretende analisar a relação entre o fenómeno do presentismo e o construto de liderança, através da análise de um novo conceito na literatura, a liderança de presentismo. Em segundo lugar, explora a liderança robótica e o impacto dos estilos de liderança humana em equipas lideradas por robôs. Terceiro, investiga o papel dos robôs como agentes promotores da saúde nos locais de trabalho, contribuindo para a melhoria de um conjunto de variáveis organizacionais. A tese inclui sete estudos empíricos, divididos em quatro artigos. Os resultados do artigo 1 sugerem que os indivíduos se consideram menos produtivos quando trabalham com um líder com uma doença psicológica ou contagiosa. O artigo 2 revela que os robôs podem desempenhar corretamente papéis de liderança em equipas humanas, alcançando os mesmos resultados organizacionais que os líderes humanos. Além disso, os robôs podem desempenhar tanto estilos de liderança transformacional como transacional, com impactos positivos em diversos resultados organizacionais. No artigo 3 foi utilizado um robô como agente promotor de comportamentos de saúde. Os resultados mostraram que a intervenção permitiu melhorar um conjunto de variáveis ligadas a comportamentos psicológicos de saúde. Finalmente, o artigo 4 visou comparar a mesma intervenção entre dois grupos: um guiado por um agente robótico e o outro por um agente humano. Os resultados mostraram que a intervenção com o agente robô esteve associada a melhorias na produtividade dos indivíduos e nos respetivos níveis de bem-estar. Esta tese contribui para a compreensão da relação entre o presentismo e a liderança, ao mesmo tempo que procura também contribuir e alargar o quadro teórico da SCT e do modelo HAPA.

Palavras-chave: presentismo; liderança; liderança robótica; comportamentos de saúde.

ABSTRACT

This thesis intends to investigate the relationship between the presenteeism phenomenon and the leadership construct, by analyzing a new concept in the literature, leadership presenteeism. Second, it explores robotic leadership and the impact of human-leadership styles in teams headed by social robots. Third, it investigates the role of robots as health-promoting agents within workplaces, contributing to workers' improvements in a set of organizational variables. The thesis includes seven empirical studies, divided in four papers. Paper 1 findings suggest that individuals perceive themselves as less productive when they work with a leader with a psychological or contagious illness. Paper 2 reveals that robots can properly perform leadership roles while leading human teams, and achieve the same organizational outcomes as human leaders. Moreover, robots performing both transformational and transactional leadership styles can impact positively different organizational outcomes. In paper 3 a robot was used as a health behavior promoting agent in a single-arm intervention, with two assessment points in time. Results showed that the intervention with the robot enabled to improve a set of psychological health behavior constructs. Finally, paper 4 aimed to compare the health behavior change intervention between two groups: one guided by a robotic agent and the other by a human agent. Results showed that the intervention with the robot agent was associated with improvements in individuals' productivity despite presenteeism and well-being levels. This thesis contributes to the understanding of the relationship between presenteeism and leadership constructs, while seeks also to contribute and extend SCT and HAPA theoretical framework.

Keywords: presenteeism; leadership: robotic leadership; health behaviors.

JEL Classification System: I12 Health Behavior; O15 Human Resources, Human Development.

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GLOSSARY OF ACRONYMS

SCT – Social Cognitive Theory

HAPA – Health Action Process Approach

CHAPTER 1

INTRODUCTION

INTRODUCTION

Presenteeism phenomenon is highly prevalent worldwide, throughout different cultures (Lu et al., 2013), and affecting not only regular employees but also self-employed workers. It is related with problematic consequences not only at an individual level but also at team (Luksyte et al., 2015), organizational and societal level (Ruhle et al., 2020). It is argued to be even more costly than absenteeism, however, it is as well a scantly understood phenomenon (Lohaus & Habermann, 2019). Although the presenteeism concept does not have yet an accepted definition to date, for this thesis we adopt the definition established by Ruhle and colleagues (2020), setting presenteeism as the behaviour of working in the state of ill-health. Several consequences of presenteeism have been mentioned on literature. First, some researchers have perceived presenteeism as either a positive or a negative phenomenon. For the present work we embrace presenteeism as being a trigger for numerous outcomes that can have the capability to be positive or negative (Ruhle et al., 2020). Thereby, presenteeism can be a natural choice for maintaining productivity if the work environment is flexible and supportive (Karanika-Murray & Biron, 2020; Lopes & Ferreira, 2020) or could be a long-term dysfunctional behavior, depending obviously on the severeness of the associated health condition (Ruhle et al., 2020). A meta-analysis by Miraglia and Johns' (2016) found out positive correlations of presenteeism with productivity loss (ρ=0.28), job satisfaction (ρ=0.12), depression (ρ=0.20), work engagement (ρ=0.13), supervisors (ρ=0.05) and role conflict (ρ=0.05). Concerning the negative correlates of presenteeism, negative correlations were found for health (ρ=−0.39), organizational support (ρ=−0.17), quality leadership (ρ=−0.13) and supervisor support (ρ=−0.10). Nonsignificant correlations were found for mental health, role ambiguity, gender, age, and education level. Although the large scope of this meta-analysis, other investigations show evidence of presenteeism affecting employee physical and mental health (Lu et al., 2013), lower work engagement (Karanika-Murray et al., 2015) and negative effects for coworkers' work engagement levels (Luksyte et al., 2015).

The field of presenteeism has been criticized because of the atheoretical approaches used in investigations of presenteeism (Johns, 2010). There is a clear absence of a theoretical model to explain presenteeism, though some recent papers already started to focus on the development of a presenteeism model (e.g., Lohaus & Habermann, 2019; Ruhle et al., 2020). Two different approaches underlying the presenteeism construct can be identified, accordingly to Lohaus and Habermann (2019). One of the approaches is labeled as "content theories", that distinguish between two types of factors influencing presenteeism: person-related aspects and job/organization aspects. The investigations focused on person and context related factors, mediators between these relationships an also some environmental factors (Cooper & Lu, 2016). The other approach used in the efforts of developing a presenteeism model is labeled as "process theories", focused on the decision-making process by which individuals decide between absenteeism and presenteeism behaviors. It is presented by Halbesleben and colleagues (2014), but only focus on the relationships between the employee and the supervisor. However, other relevant aspects such as health problems, team factors and environmental influences are not taken into account (Lohaus & Habermann, 2019). Moreover, a common facet of all these approaches is the lack of attention given on the role of the leader and its behaviors.

Few systematic studies conducted over the last decade have sought to understand the influence leaders' presenteeism behavior has on employee and team productivity (ten Brummelhuis et al., 2016). As stated earlier, previous studies have included colleagues (i.e., team members) (e.g., Luksyte et al., 2015; Yang et al., 2021), however, researchers and managers also need to investigate whether and how leaders' different health conditions can impact the productivity of individuals and teams. To our knowledge, only one recent investigation has focused on leaders presenteeism. Dietz and colleagues (2020) analyzed leader health-related behaviours in the form of presenteeism, and found out that leaders who shows presenteeism behaviors may have to deal with subsequent employee presenteeism, and higher levels of employee sick leave. This shows that leaders' health conditions affect workers' productivity and reveal the hidden dangers of working with a sick leader. It also constitutes evidence that leaders may have a determinant role in spreading a presenteeism-culture within organizations. Herewith, in order to contribute to the establishment of a presenteeism theory, this thesis focuses on leadership presenteeism construct.

Besides that, the literature on presenteeism have also been centered on the health conditions that are associated with the act of attending to work while feeling ill. In order to understand the presenteeism phenomenon, one must understand how illness is connected to presenteeism behaviors. This is particularly relevant for management and human resource field since some health conditions may be more related to presenteeism and other more associated to absenteeism behaviors (Gosselin et al., 2013). Several studies have inferred the health conditions linked to higher levels of productivity losses (Bouwmans et al., 2014; Hemp, 2004; Whysall et al., 2018). Since illness is not a one-dimensional construct, presenteeism research has distinguished between occasional and chronic illness and between psychological and physical illness (Karanika-Murray & Cooper, 2018). Hemp (2004) found out that the most prevalent health conditions in the workplace were the ones related to psychological illnesses and physical chronic conditions. More recent research by Whysall and colleagues (2018) determined contagious physical illnesses, psychological conditions and non-contagious physical conditions the most prevalent workplace health problems and accounting for the largest number of days presenteeism. Based on these relevant findings, for the present thesis we choose to focus on the following health conditions: non-contagious physical illnesses (i.e., arthritis, dermatitis, and allergies or sinusitis), psychological illnesses (i.e., depression and anxiety), and contagious physical illnesses (i.e., influenza/flu). By analyzing and comparing each one of these health problems groups, we can focus on the different demands that each one of these illnesses sets on individuals. Therefore, it can be possible to identify support techniques and resources that managers must provide to their employees, in order to facilitate recovery and return to work (Karanika-Murray & Cooper, 2018).

Presenteeism and its relationship with engagement and role ambiguity

Role ambiguity and engagement are two variables that have been studied extensively in the organizational context, since there is existing evidence that they may affect the functioning of individuals or teams (Lee et al., 2017; Ma et al., 2018). Furthermore, these variables have also been associated with employees' poor general health (Inoue et al., 2018), thus making them relevant to explore in the context of presenteeism. By focusing on these factors, it can be better understood how working while sick may affect employees attitudinal and motivational responses towards their work, in the form of lower engagement and higher role ambiguity (Côté et al., 2021).

Role ambiguity has been defined as the extent to which an individual is uncertain about job performance expectations and, therefore, lacks certainty and clarity about what they should accomplish in their work (Rizzo et al., 1970; Schuler et al., 1977). On that basis, it can also be defined as a lack of role clarity, which means that when there is no role ambiguity, there is role clarity and vice-versa (Inoue et al., 2018). A considerable amount of research has shown that role ambiguity can cause lower productivity and affect a person's ability to perform effectively (Linardakis et al., 2017; Zhou et al., 2016). Additionally, there is also evidence of the association between role ambiguity and poor physical and mental health, in the form of anxiety and depression (Schmidt et al., 2014). Role ambiguity has also been negatively related with productivity associated with presenteeism (Zhou et al., 2016).

Employee engagement has been an organizational variable conceptualized in several ways, all of which include behavioral, cognitive and affective dimensions, with specific characteristics that can influence employees differently(Lee et al., 2017). Although having employees who are engaged should be one of an organizational leader's top priorities (Batista-Taran et al., 2009), it is important to establish that having engaged employees is different from having productive employees. In this thesis we explore individuals' emotional and behavioral reactions to leaders' presenteeism by analyzing physical engagement and emotional engagement. Physical engagement concerns the investment of effort, physical energy, and hard work with regard to task completion, whereas emotional engagement concerns emotional and affective reactions related to the work role itself (Luksyte et al., 2015; Mañas et al., 2018). Although Miraglia and Johns (2016) meta-analysis has revealed a positive association between presenteeism and work engagement, several studies have reported the opposite (Karanika-Murray et al., 2015; Lu et al., 2013), showing that working while sick can have a negative influence on some job attitudes. Furthermore, other recent studies have found a negative association between presenteeism and work engagement (Côté et al., 2021; Fiorini & Houdmont, 2018).

Extending Social Cognitive Theory to leadership presenteeism

The theoretical background of this thesis relies on Social Cognitive Theory (SCT) (Wood & Bandura, 1989). SCT is an extension of the Social Learning Theory, and states that knowledge acquisition takes place within environments in which observations can be made based on social resources. In particular, the basic assumptions of the theory take on board the processes of modeling, observational learning and social influence to produce behavior, thus enabling individuals to be active agents who both influence and are influenced by the environment (Bandura, 2004). As cognitive agents who regulate their actions, people are interactive agents who co-operate with the environment, dealing with experiences that give meaning, enjoyment, and direction to their lives (Bandura, 2000). We anchor SCT as the basic framework for this thesis, following the growing literature that connects presenteeism to social-cognitive psychological processes (e.g., Cooper & Lu, 2016b; Karanika-Murray & Biron, 2020).

Specifically, SCT can provide our research with a theoretical basis from which the subjacent processes between presenteeism and leadership can be explained, in particular, leadership presenteeism. Notwithstanding, SCT can also be applied to human-robot interaction field and health behavior change, topics that we will focus later on. We connect the leadership presenteeism construct to the human agency theory (Bandura, 2018) by emphasizing the role of the leader as a social agent – a proxy agent – the holder of specific social characteristics that can foster presenteeism behaviors in their followers. However, in order to understand this, we first need to analyze in more detail the core properties of human agency, since we considered that they can bring a more effective explanation to the concept of leadership presenteeism.

According to Bandura (2006), the first property of human agency is intentionality, which concerns the intentions people form regarding their action plans and strategies for realizing them. At an organizational level, effective group performance must be guided by a shared collective intentionality that can be assumed by leaders. The second agentic property is forethought, which includes the temporal extension of agency. It’s a form of anticipatory self-guidance, where the behavior is governed by visualized goals and anticipated outcomes, which provides direction, coherence and meaning to one's life. Again, leaders in work environments can be responsible for fostering forethoughtful behavior among their followers. The third property agent is self-reactiveness, which concerns the ability to construct appropriate courses of action and to motivate and regulate their execution. Finally, the last core property of human agency is self-reflectiveness, which enables individuals to reflect on their personal efficacy and the meaning of their pursuits. It is the most distinctly human core property of agency (Bandura, 2006). Moreover, since people do not operate as autonomous agents, SCT distinguishes among three modes of agency - individual, proxy, and collective – which together create a triadic interaction (Bandura, 2018). In many circles of functioning, such as work environments, employees do not have direct control over some conditions that affect their working lives. Instead, they are mediated by a proxy agent, i.e., their leaders. This interdependency between the individual mode and the proxy mode of agency is a key ingredient for collective agency (Bandura, 2006), and is the basis of diverse social systems, such as organizations.

As stated in SCT, to be an agent is to intentionally influence one's functioning through personal influence (Bandura, 2018). Through modeling influence, the learning experience occurs vicariously by observing individuals' behavior and the consequences of it (Wood & Bandura, 1989). In organizational settings, when individuals observe a model worker's behavior and its consequences (such as that of leaders), they remember the sequence of events and use this information to guide their own future behavior. In accordance with SCT, leaders can be considered proxy agents (Bandura, 2018), which means that they are seen as role models(Hogg, 2001) and have the possibility to influence social and organizational aspects (Rigotti et al., 2014). If employees observe their leaders coming to work sick, they may react more strongly to leaders' health conditions than to other coworkers' illnesses. Reactions may culminate in unfavorable behavioral reactions such as lower productivity. This is also in line with the work from Dietz and colleagues (2020) that states that leaders' presenteeism level acts as a behavioral cue for employees, shaping their own reactions and presenteeism levels.

From human leadership to robot leadership

Recent advances in the field of human-robot interaction are causing humans to work more closely with robots and to successfully integrate them into work environments (Savela et al., 2021). Hence the urgent need to know more about how robots impact the interpersonal dynamics of teams, and how they can affect work outcomes. For this thesis, we also intend to contribute for the convergence of leadership styles theories and human-robot interaction field, through the application of human leadership styles to robotic behaviors. In sum, we explore the possibility of robotic leadership.

Adapting human leadership theories to the field of human-robot interaction constitutes a potential challenge that has neither been captured by recent research in human-robot interaction nor has been sufficiently explored by researchers in management and artificial intelligence fields. If implemented appropriately in organizations, robots can help people enjoy the potential benefits provided by technology, whatever their age or technological literacy level. Previous research has shown that individuals exhibit unique and favorable responses to physically present social robots (Samani & Cheok, 2011). Since robots are machines programmed to operate semi or fully autonomously, they may have the capability to perform roles increasingly similar to those performed by humans (Dang & Liu, 2021; You & Robert, 2018). Prior work has also supported the assumption that the same principles that govern groups and teams of people can be applied in human-robot teams and groups (Canbek, 2019). For this reason, we theorize that social robots are able to fulfill the role of leader in teams and groups of people. We do not, however, aim to determine whether robots can be better leaders than humans, or whether or not a robot can lead human teams (although that seems to be most certainly possible). On the contrary, we seek to investigate and provide evidence of how robots can be effective leaders. Like, for example, which characteristics should robot leaders display, and do these characteristics differ or not from human leadership characteristics? In order to do so, the starting point must be to concentrate on human-leadership theoretical frameworks.

Among the several human-leadership paradigms addressed in management literature, transformational and transactional leadership styles, are the most commonly mentioned, being part of the full-range leadership model (Bass et al., 2003). A transformational leader motivates and inspires their followers to increase their productivity to accomplish a common goal, directing their behavior toward a shared vision (Judge & Piccol, 2004). Factors such as exhibiting charismatic behaviors, intellectual stimulation and inspirational motivation have all been associated with transformational leadership (Batista-Taran et al., 2009). A transactional leader focuses on supervision, organization and clarification of expectations, providing recognition if goals are achieved (Batista-Taran et al., 2009). Following these theoretical lines, we intend to explore which leadership styles and respective behaviors are most appropriate for a robot to display. Adopting human-leadership styles in human-robot interaction scenarios can help to identify and adjust robot characteristics to specific contexts, in order to facilitate humans' acceptance of robot leaders in work environments (Canbek, 2019; Kolbjørnsrud et al., 2016). In addition, we also want to investigate the relationship between robot leadership behaviors and the further organizational variables which are part of this thesis, namely employee productivity, role ambiguity and work engagement (Judge & Piccol, 2004; Villotti et al., 2014).

Robot as health-promoting agents within organizations

People usually engage in a variety of behaviors that can aggravate or harm their existing health problems or lead to new medical complications (Domke et al., 2019). According to the World Health Organization (WHO, 2018), some common lifestyle behaviors, such as physical inactivity, bad nutrition habits, stress and tobacco consumption are at the core of several health problems and lower quality of life levels. Providing general information paired with personalized interventions and continuous feedback has proven to contribute to the acquisition of daily healthier choices (Robinson et al., 2021). Health behavior change incorporates a range of social, emotional and cognitive changes, linked with each other in order to predict and explain health behavior change processes (Schwarzer, 2008).

The Health Action Process Approach (HAPA) is a social cognitive model with the aim to describe, explain and modify health behaviors within individuals (Schwarzer, 1992, 2008). The model was conceived as a framework to conceptualize health self-regulation as process that can be partitioned into stages, in which several psychological constructs enable individuals to improve their health and well-being (Schwarzer & Hamilton, 2020). This model has been used for several applications, for example, to improve fruit and vegetable intake (Domke et al., 2019; Kreausukon et al., 2012), to promote oral health (Scheerman et al., 2020) and to improve adherence to influenza vaccination (Ernsting et al., 2013). Since the characteristics of this model in explaining health behavior change, our final goal with this thesis was to test the efficacy of a theory-based intervention delivered exclusively by a robotic agent, in order to promote health behavior change among employees of organizations. The unique feature of this model is that explicitly accounts for social-cognitive predictors that operate when translating intentions into behavior (Ernsting et al., 2013). The HAPA framework derives from the SCT, utilized to explain the adoption, initiation, and maintenance of health behaviors. On both theories, subjective cognitive processes play a crucial role, so that motivation can be translated into real behavioral changes (Bandura, 2006).

The HAPA framework adapts and extends two key constructs of SCT, namely self-efficacy and outcome expectancies (Luszczynska & Schwarzer, 2015). According to SCT, these two concepts influence goal setting and goal pursuit, being related to the adoption of health-promoting behaviors and to behavioral change (Luszczynska & Schwarzer, 2015). However, HAPA was designed to extend in particular the goal pursuit phase, by taking into consideration other predictors, such as planning, maintenance, and recovery (Schwarzer & Renner, 2000). Below we provide some knowledge regarding the key theoretical constructs of the HAPA model. Together, these constructs and the subsequent proposed mechanisms, constitute the theoretical framework of the HAPA: intention, risk perception, outcome expectancies, self-efficacy, action planning, and coping planning. Intention is an essential construct of the model, reflecting the extent to which people will invest effort in change their previous way of life and set goals for a given health behavior in the future (Zhang et al., 2019). It is conceptualized as the most proximal predictor of future behavior (Schwarzer & Hamilton, 2020), and it's a significantly predictor of action planning, coping planning, and behavior (Zhang et al., 2019). Risk perception is the extent to which individuals perceive a health threat, regarding their personal risk or susceptibility to particular health dangers. It is considered to be a fundamental pre-requisite for individuals to be motivated to change their risky behavior, however, is itself insufficient to develop a motivation to change, unless other variables are present (Schwarzer, 2008). On literature has been conceptualized as a significantly predictor of intention (Scheerman et al., 2020). Outcome expectancies reflects beliefs about the benefits or costs that people expect to experience, by adopting or not the behavior. They are good predictors of intentions (Zhang et al., 2019). Self-efficacy concerns individuals' beliefs about their personal ability to exercise control of their behavior, even when confronted with potential barriers or challenges (Schwarzer & Hamilton, 2020). It has also been applied as predictor of action planning and coping planning (Zhang et al., 2019). Planning can be divided onto action planning and coping planning. Those are theorized as proximal determinants of behavior, to be expected to ensure that intentions are converted to behavior. Action planning refers to a task-facilitating strategy that assists people in identifying cues that can lead to action, such when, where, and how one intends to perform the behavior (Zhang et al., 2019). In turn, coping planning involves the anticipation of potential barriers that may appear in the process of the adoption and maintenance of the behavior, and generate plans to manage or overcome them (Schwarzer, 2008). The HAPA model theorizes two distinct phases (Schwarzer & Hamilton, 2020). The first is the motivational phase, where individuals form intentions to change their behavior. This phase encompasses the constructs of outcome expectancies, risk perception and self-efficacy. The second phase is known as the volitional phase, where two components operate in the enactment of intentions, namely action planning and coping planning (Zhang et al., 2019). For greater interventions' outcomes, it is suggested that research based on HAPA focuses on those two distinct phases, in order to encompass the overall longitudinal mediator mechanism that is unique to the HAPA model (Schwarzer & Hamilton, 2020). Below it is presented the model figure (Figure 1).

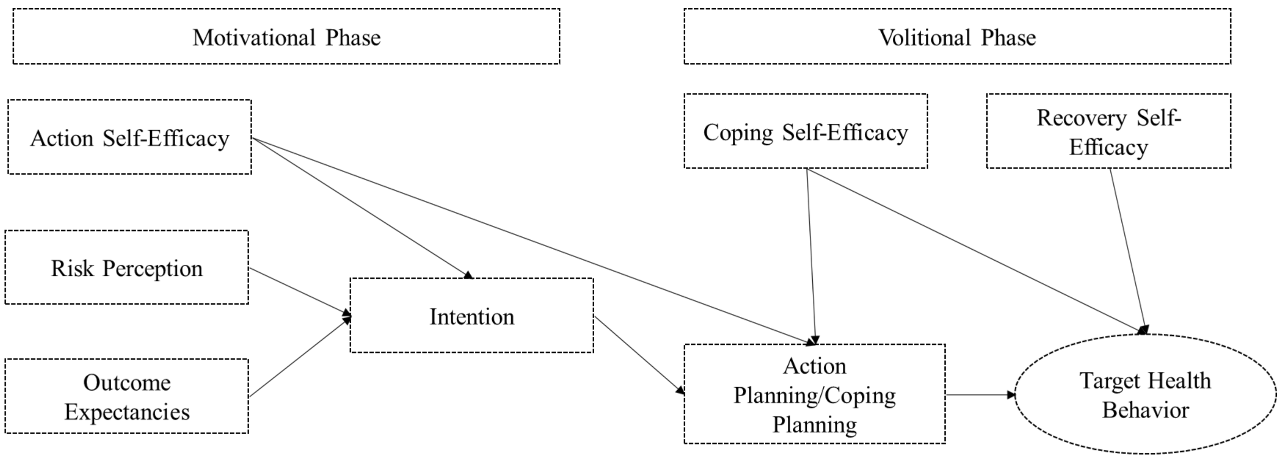

Figure 1.1 The Health Action Process Approach (HAPA; adapted from (Schwarzer, 1992, 2008)

Following recent recommendations (Zhang et al., 2019), in this thesis we are specifically interested in contributing to the research on HAPA model by analyzing new intervening variables between the motivational and volitional phase. Furthermore, although the large evidence of the relevance of applying HAPA theoretical model for health behavior change in adult populations (Ernsting et al., 2013; Prem et al., 2021; Rollo & Prapavessis, 2020), as far as we know, very few studies in the literature have specifically addressed the application of the HAPA model in working populations. This is even more relevant when we focus on the use of artificial intelligence machines such as social robots to promote healthier behaviors among employees. Aiming to overcome this gap, we developed a longitudinal design with two assessment points over a three-month period, to test a series of predictions inspired by the HAPA constructs, in an intervention leaded by a social robot or a human agent. To our knowledge, this is the first time the HAPA framework is applied through the role of a non-human agent.

The innovative element of this thesis is the application of the HAPA model through the use of a social robot as health-promoting agent. The use of social robots to provide guidance for health behavior change can offer higher flexibility compared to ‘normal’ telemedicine methods (Sarma et al., 2014). This study follows the definition of social robot given by Bartneck and Forlizzi (2004, p.2): *“a social robot is an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact”*. Social robots have been used to provide therapeutic assistance in healthcare for a wide-ranging of users, from children to adults and even for the elderly (Cao et al., 2019; Vlachos & Schärfe, 2014). They can be used to motivate, coach, educate, provide feedback and social support, and improve compliance with health behavior change programs. Their ability to interact and communicate with people provides some unique advantages compared to other technologies, such as smartphones applications, computers, or screen-based avatars (Breazeal, 2011). The use of social robots that assist and guide individuals to change health behaviors can provide greater flexibility in telemedicine practices, however, it’s a field which little attention has been paid so far (Sarma et al., 2014). Social robots can have the potential to serve as tools to improve individuals well-being, and consequently, their productivity at work. The use of social robots can be an effective way to give personalized health feedback to employees, bringing consciousness to behaviors that can influence health outcomes. If implemented well, they can become an important health prevention tool to promote healthy lifestyles within individuals in organizations (Robinson et al., 2021).

Summary

As presenteeism phenomenon begins to emerge on organizations agendas, it is crucial to expand from the individual approach that has been guided presenteeism research to other organizational interveners that can also be involved. Specifically, we shed a light on the role leaders may have on spreading presenteeism among workplaces, contributing to fill this gap on presenteeism literature. Work engagement and role ambiguity will also be analyzed throughout the different studies that constitute this thesis. Both constructs are valuable and important to understand the role of presenteeism on the organizational context. Further, we consider that robotic leadership deserves the attention of researchers. Robot-based leadership will have a promising future in the years to come, so it is fundamental to maintain focus on investigating the unique value that robot leadership can bring to workplace settings, and on how individuals and teams work with their new artificially intelligent partners. Additionally, this thesis intends to fill the gap in the literature of health behavior change through the use of social robots, that can be applied to create more healthier and vigorous work environments, and this way, reduce the negative consequences of going to work while ill. Lastly, with this thesis we seek to contribute and extend SCT and HAPA theoretical framework and their subsequent applications, that move beyond exclusively human-interaction scenarios.

Aim and overview of the thesis

The aim of this thesis is threefold. First, we[1] aim to investigate the relationship between the presenteeism phenomenon and the leadership construct. To do so, we introduce a new concept in the literature, the leadership presenteeism concept. We start from the assumption that leaders might have a determining role in fostering presenteeism among employees, so we intend to understand the impact of leaders' health on subordinates. Second, we continue to focus on the concept of leadership, but with a novel perspective, by exploring robotic leadership and the impact of human-leadership styles in teams headed by social robots. The expectation is that social robots can be capable of serving as leaders for human teams in order to improve the organizational requirements of the workplace environment. Third, we maintain the focus on social robots, but we explore the role of robots as health-promoting agents within workplaces, contributing to workers' improvements in a set of organizational and individual variables. Related to this last objective, we aim to analyze it in two distinct ways: by applying the HAPA model to the human-robot interaction field and to compare the role of a human agent and a robotic agent in a health-promoting intervention. In order to accomplish these objectives, seven empirical studies were developed, resulting in four papers, using different methodological approaches and data collection from various sources (with the exception of the papers reported in chapters 4 and 5 in which the same sample was used).

In chapter 2 (the first paper) we analyze the influence that leaders' presenteeism behavior has on employee and team productivity. Specifically, we investigate whether and how leaders' different health conditions can impact the productivity of individuals and teams, as well as other organizational features, such as role ambiguity and engagement. We first conducted a study within a university-students sample to understand which leaders' health conditions would most influence team productivity, role ambiguity and engagement. Further, in study 2 we manipulated leaders' health status in an experimental study. We found out that individuals perceive themselves as less productive when they must work with a leader with a psychological or contagious illness. Moreover, physical engagement was found to be a mediator between role ambiguity and team performance. A qualitative analyses support these conclusions. Finally, to overcome the limitation of the student population used in both studies 1 and 2, study 3 was developed specifically for the working population, with employees who worked regularly with their leaders. Results are in line with studies one and two's findings.

In chapter 3 (the second paper) we analyze robot leadership and the impact of human-leadership styles in teams headed by social robots. To understand how robot leadership can be a reality in the imminent future and how robots can display efficient leadership roles, we looked at the practices of the leadership styles defined in human relationships. We first explored through an experimental design teams' perceptions of robot leadership behaviors, and analyzed the robots' influence on a set of organizational outcomes, specifically productivity, engagement and role ambiguity (study 4). We compared productivity, role ambiguity and engagement outcomes in 65 teams. Teams had to perform an organizational task with either a robot leader or a human leader. Our results showed that robots can properly perform leadership roles while leading human teams, and can also achieve the same organizational outcomes as human leaders. Subsequently, we examined the teams' perceptions of robots performing leadership roles typically associated with human leadership styles, particularly transformational and transactional leadership (study 5). The same experiment was conducted in order to determine which human-leadership styles would be associated with better organizational results. Thirty-six teams had to work with a robot acting in accordance with a leader script, which corresponded either to transformational or transactional leadership. Results showed that both transformational and transactional leadership styles can have positive impacts on different organizational outcomes.

In chapter 4 (the third paper) we analyzed the use of a social robot to promote healthier behaviors among employees. It was developed a longitudinal study (study 6) with two assessment points over a three-month period, to test a series of predictions inspired by the HAPA constructs. The interaction with the robot was designed to assess a key-modifiable risk behavior for each participant and providing personalized feedback throughout the sessions. The intervention with the social robot enabled to improve all HAPA psychological constructs between Time 1 and Time 2. Moreover, intentions were found out to be a mediator of the relationship between the motivational phase and the volitional phase.

In chapter 5 (the fourth paper) we aimed to compare the same longitudinal health behavior change intervention (study 7) between two groups: one guided by a robotic agent and the other guided by a human agent. The main focus of the study was to analyze which type of agent would be associated with better results in a set of individual and organizational outcomes. Our results showed that the intervention with the robot agent was associated with improvements in individuals' productivity despite sickness presenteeism and well-being levels. However, no effects were found regarding the engagement levels of participants.

In chapter 6, a general conclusion is presented by discussing overall contributions and implications of this thesis, and future research directions are provided. The research model is presented in figure 1.2.

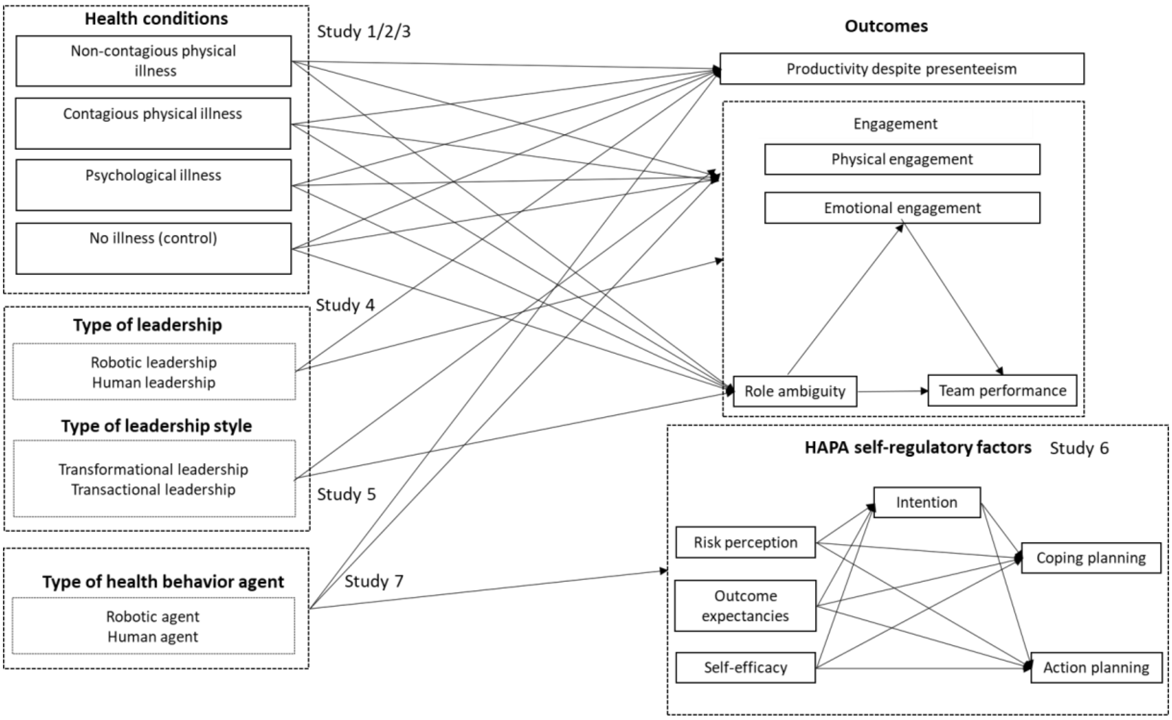

Figure 1.2. The research model of this thesis.

CHAPTER 2[2]

WHEN PRESENTEEISM GOES VIRAL: THE IMPACT OF LEADERS' HEALTH ON SUBORDINATES.

[2]This work is currently under review in *Journal of Applied Psychology* as: Lopes, S. L., Ferreira, A. I., & Prada, R. When presenteeism goes viral: the impact of leaders' health on subordinates.

Abstract

Leaders might play a determining role in fostering presenteeism among employees, since they can affect the latter's engagement and commitment to work. A limited number of studies have sought to understand the influence that leaders' presenteeism behavior can exert on employee and team productivity. Drawing upon the Social Cognitive Theory, we conducted a mixed-method approach and an experimental study to understand which leaders' health conditions most influence team productivity, role ambiguity and engagement. Study one's (N=336) results suggest that individuals perceive themselves as less productive when they must work with a leader with a psychological or contagious illness. For study two (N=250), we manipulated leaders' health status, and found general support for our predictions from study one. Qualitative analyses support the conclusions both from studies one and two. Moreover, physical engagement was found to be a mediator between role ambiguity and team performance.

To overcome the limitation of the student population used in both studies 1 and 2 (i.e., a lack of ecological validity), study 3 was developed specifically for the working population, with employees who worked regularly with their leaders. Results (N=182) are in line with studies one and two's findings. This study contributes to bringing Social Cognitive Theory to the presenteeism and leadership literature, by suggesting that leaders' health-related conditions can have consequences for employee productivity and a range of organizational outcomes. Theoretical and practical implications are discussed.

Keywords: Presenteeism, leadership, health condition; productivity, mixed-method approach.

INTRODUCTION

The global phenomenon of presenteeism, defined in the literature as going to work while ill (Karanika-Murray & Biron, 2020), can generate several costs not only for individuals, but also for organizations and society as a whole (Whysall et al., 2018). Presenteeism is estimated to be related to 6.8% and 60% of companies' total health-related costs(Luksyte et al., 2015b). Sick employees and leaders who choose to be present at work despite their illnesses expose their colleagues to health risks (Bokhari et al., 2017). Recent data show that the prevalence of employees who work even though they present symptoms of illness is estimated to be between 30% and 90%(Dietz et al., 2020b). These numbers reveal the substantial financial costs to organizations of presenteeism(Karanika-Murray & Cooper, 2018). However, the wide-ranging costs of presenteeism may currently be even higher, because of the additional risks caused by the COVID-19 pandemic the world is facing today. It is expected that presenteeism behaviors will become more prevalent, giving rise to post-pandemic challenges for employees and affecting companies effectiveness (J. W. Chen et al., 2021). Thus, it is more crucial than ever to investigate the social and cognitive mechanisms underlying presenteeism phenomena, and the role played by different organizational stakeholders.

Social Cognitive Theory (SCT)(Wood & Bandura, 1989a) states that knowledge acquisition takes place within environments in which observations can be made based on social resources. In particular, the basic assumptions of the theory take on board the processes of modeling, observational learning and social influence to produce behavior, thus enabling individuals to be active agents who both influence and are influenced by the environment (Bandura, 2004). This investigation attempts to adapt and extend those general aspects of SCT that appear to be most relevant to the presenteeism phenomenon.

Following the growing literature that links presenteeism to social-cognitive psychological processes (e.g., Cooper & Lu, 2016; Karanika-Murray & Biron, 2020), we anchor SCT as the basic framework for this present paper. SCT has been used in a wide range of psychological domains (Bandura, 1989, 2006)which can provide our research with a theoretical basis from which the subjacent processes between presenteeism and leadership can be explained. In particular, we examine whether a specific type of leader behavior, leader presenteeism, can influence team productivity and other organizational outcomes. By linking the leadership construct to the human agency theory(Bandura, 2018) , we emphasize the role of the leader as a social agent – a proxy agent – the possessor of specific social characteristics that can foster presenteeism behaviors in their followers. In accordance with SCT, leaders can influence their employees' presenteeism behavior since, being role models (Hogg, 2001), they may be seen as proxy agents. Through this proxy agency, leaders influence others (employees) to act on their behalf, to secure desired outcomes (e.g. higher performance and productivity, higher engagement levels…).

Despite the pertinence of this topic, few systematic studies conducted over the last decade have sought to understand the influence leaders' presenteeism behavior has on employee and team productivity (ten Brummelhuis et al., 2016). Previous studies have included colleagues (i.e., team members) (cf. Luksyte et al., 2015), however, researchers and managers also need to investigate whether and how leaders' different health conditions can impact the productivity of individuals and teams, as well as other organizational features.

Accordingly, we argue that employees observe leaders' presenteeism and are influenced by their behavior, which can lead to negative outcomes. Considering workers may have closer and more frequent interactions with their supervisors (Luksyte et al., 2015), if they see their leader going to work sick, they may also exhibit higher levels of presenteeism. We consider that leader presenteeism increases the risk of employee presenteeism through leaders' role-modeling (Dietz et al., 2020b). Leaders are an important source of social influence in the work environment, playing a key role in workers' daily activities (Dietz et al., 2020).

We focus on a range of the most prevalent health conditions in work environments, those associated with higher levels of productivity losses namely - physical, psychological, and contagious illnesses (Whysall et al., 2018). Since globalization has made different economies more interconnected, making public-health emergencies of international concern, it is important to consider how infectious diseases, in particular, play a role in the dynamics of leaders and employees' presenteeism and productivity. Contagious physical illnesses (such as influenza, or the common cold) are diseases that are transmitted by contact from an infected person to another person(Webster et al., 2019). For instance, with the spread of the COVID-19 pandemic, it has been stated that leaders and employees' absenteeism can lead to economic damages for companies of as much as trillions of dollars. However, these individuals may choose to go to work, even though they are infected, thus causing the disease to spread among others and consequently, causing the company financial losses. Data on the impact of presenteeism of employees with infectious diseases, have not been fully explored (Webster et al., 2019). What impact could a leader infected with such a disease have if they decide to go to work? Not all countries control all travelers entering and exiting their boarders, therefore, it is interesting to understand how a leader with a contagious illness in the workplace could affect others, and what the cost would be in terms of financial strain on the organization.

As mentioned before, in the current research, we extend SCT to organizational settings, as previously theorized by some authors (Cooper & Lu, 2016b; Fearon et al., 2013; Wood & Bandura, 1989a). We aim to use the key elements of SCT to explain how leaders' presenteeism occurs in organizations. We focus on two organizational variables – role ambiguity and engagement - that are particularly relevant to understand productivity despite presenteeism (Ruhle et al., 2020; Zhou et al., 2016). By doing this, we try to highlight some organizational mechanisms that may be used to form the link between SCT and leaders' presenteeism phenomena. Role ambiguity and engagement are two organizational variables that have been linked to workers' general health and productivity level (Inoue et al., 2018a) that affect the normal functioning of teams. Therefore, in the scope of this investigation, it is relevant to study how team role ambiguity and engagement can be affected by leaders' different health conditions.

Our research makes several important contributions to the literature. Firstly, the literature has so far been dominated by an individual-focused approach, emphasizing the individual consequences of presenteeism for productivity losses (Gosselin et al., 2013)). This focus on individual agency gives an incomplete picture of the presenteeism phenomenon. To the best of our knowledge, there is only one investigation that examined presenteeism from the perspective of coworkers (Luksyte et al., 2015), and one other that examined leaders' presenteeism and employee health (Dietz et al., 2020b). Our work investigates the impact of leaders' health conditions on employees productivity losses, and enriches the literature by providing a more collective understanding of presenteeism in the workplace. By conceptualizing leaders as proxy agents within organizations that contribute actively to a collective agency, we extend SCT to leaders' presenteeism construct. Secondly, the existing literature on presenteeism relies primarily on self-reported measures (Luksyte et al., 2015). To meet the challenges of studying presenteeism in experimental settings, we developed an experimental study with empirical manipulations to test our hypotheses, seeking in this way to complement the existing literature on presenteeism. To the best of our knowledge, this is one of the first investigations to manipulate leaders' health conditions in an experimental setting. As far as we know, it is also the first study to analyze how teams work in a presenteeism context. Finally, another strength of the present research is that it uses a mixed-method approach based on a combination of a survey and a qualitative analysis of semi-structured interviews. We chose to integrate quantitative and qualitative methods in order to provide complementarity in our data analyses and clarify the results through qualitative analyses(Bryman, 2006).

THEORETICAL BACKGROUND AND HYPOTHESIS

Extending Social Cognitive Theory to leaders' presenteeism

SCT adopts an agentic perspective toward human development, adaptation, and change (Bandura, 2006). Similarly to Dietz and colleagues (2020), our goal is to adapt and extend the general aspects of SCT to the collective understanding of presenteeism behavior, and specifically, leaders' presenteeism. However, we go further as we attempt to include in the link between SCT and presenteeism to the four core properties of human agency, since we considered that they can bring a more effective explanation to the concept of leadership presenteeism.

According to Bandura(2006), the first property of human agency is intentionality, which concerns the intentions people form regarding their action plans and strategies for realizing them. At an organizational level, effective group performance must be guided by a shared collective intentionality that can be assumed by leaders. The second agentic property is forethought, which includes the temporal extension of agency. It's a form of anticipatory self-guidance, where the behavior is governed by visualized goals and anticipated outcomes, which provides direction, coherence and meaning to one's life. Again, leaders in work environments can be responsible for fostering forethoughtful behavior among their followers. The third property agent is self-reactiveness, which concerns the ability to construct appropriate courses of action and to motivate and regulate their execution. Finally, the last core property of human agency is self-reflectiveness, which enables individuals to reflect on their personal efficacy and the meaning of their pursuits. It is the most distinctly human core property of agency (Bandura, 2006).

Moreover, since people do not operate as autonomous agents, SCT distinguishes among three modes of agency - individual, proxy, and collective – which together create a triadic interaction (Bandura, 2018). In many circles of functioning, such as work environments, employees do not have direct control over some conditions that affect their working lives. Instead, they are mediated by a proxy agent, i.e., their leaders. This interdependency between the individual mode and the proxy mode of agency is a key ingredient for collective agency (Bandura, 2006), and is the basis of diverse social systems, such as organizations. As stated in SCT, to be an agent is to intentionally influence one's functioning through personal influence (Bandura, 2018). Through modeling influence, the learning experience occurs vicariously by observing individuals' behavior and the consequences of it (Wood & Bandura, 1989a). In organizational settings, when individuals observe a model worker's behavior and its consequences (such as that of leaders), they remember the sequence of events and use this information to guide their own future behavior. Social models can serve as transmitters of new styles of behavior for the observers, through modeled emotional experiences(Dietz et al., 2020b). By observing the behavior of role models, social learning can also occur in the work environment (Dietz et al., 2020b). In accordance with SCT, leaders can be considered proxy agents (Bandura, 2017), which means that they are seen as role models (Hogg, 2001) and have the possibility to influence social and organizational aspects (Rigotti et al., 2014). If employees observe their leaders coming to work sick, they may react more strongly to leaders' health conditions than to other coworkers' illnesses. Reactions may culminate in unfavorable behavioral reactions such as lower productivity. Therefore, within the scope of this paper, we focus our perspective on productivity losses related to leaders' presenteeism, i.e. employees' lower productivity due to leaders' health problems, which is undoubtedly of great importance for companies (Ruhle et al., 2020).

It is also possible that individuals may react differently to leaders' health conditions depending on whether they have frequent and close interactions with them (Luksyte et al., 2015). For example, frequent and close interactions with a leader suffering from a psychological condition may affect employee productivity in the long-term, because people feel uncomfortable working with someone with mental illnesses (Rüsch et al., 2005). There is evidence that employers are more distrustful of colleagues with psychological problems than any other type of disability (Peters & Brown, 2009). People with mental illnesses can be seen as less capable in their work, creating fear among those in the workplace with whom they have more direct contact, which in turn, may affect the organizational environment. Conversely, if it is the first time a person/team is working with a new leader to achieve a common goal or accomplish a task, leaders showing signs of a contagious physical disease may cause stress or other negative behavioral reactions that could affect productivity outcomes (Luksyte et al., 2015a). Taking SCT again into consideration (Bandura, 1989), since we have no previous social interactions and experience with the sick person, this could lead to the negative cognitive process of fear of contagion. This risk perception may be a predictor of negative behavioral reactions, such as lower productivity, lower engagement, and higher role ambiguity.

Moreover, in order to improve our knowledge regarding the effects of leaders' presenteeism on engagement, productivity and role ambiguity, SCT can bring an understanding of cognitive processes and its relationship with some organizational variables. The idea of collective agency can be applied to these variables, since they can contribute to a group perception of their overall capability to deliver performance goals, as already stipulated by previous theoretical works (e.g., Fearon et al., 2013).

To ascertain the validity of these assumptions, we collected data from two different scenarios: in study 2, individuals worked with a leader they had just met and with whom they had had no past interactions, while in study 3, we collected data from employees who worked closely and regularly with their leaders. Drawing on SCT, this investigation tried to adapt and extend the primary features of the general theory, linking them to presenteeism and leadership constructs, as well as to several organizational outcomes. This paper aims to integrate social-cognitive aspects in the field of presenteeism research, to promote healthier work environments to all organizational stakeholders.

Health Conditions and Presenteeism

Several health conditions can influence presenteeism (Hemp, 2004; Whysall et al., 2018). Previous authors (Bouwmans et al., 2014; Whysall et al., 2018) have reported their conclusions about the most prevalent health conditions in the workplace and the average productivity losses these conditions cause. Based on these findings, this present investigation focused on the following health conditions: non-contagious physical illnesses (i.e., arthritis, dermatitis, and allergies or sinusitis), psychological illnesses (i.e., depression and anxiety), and contagious physical illnesses (i.e., influenza).

Experts estimate that presenteeism accounts for 41% of total productivity losses among individuals with arthritis(W. Zhang et al., 2010). People with arthritis often face challenges in the workplace, including difficulty moving around, prolonged sitting and standing, lifting, working with their hands, concentrating, and accomplishing tasks(Tang, Beaton, et al., 2011). Previous investigations established coworkers' attitudes and coworker and organizational social support as some of the main factors that could indirectly impact whether a person with arthritis is productive at work (Tang, Escorpizo, et al., 2011).

Psychological conditions are among the most prevalent illnesses reported in the workplace, and are associated with productivity losses ranging from 7.6% to 18.5% (Bouwmans et al., 2014; Hemp, 2004). The literature also reveals that people with mental illnesses are often stigmatized by society (Rüsch et al., 2005). This may indicate that employees feel uncomfortable working with colleagues suffering from psychological illnesses. Mental conditions can create problems both for coworkers and the individuals suffering from these illnesses, which have deleterious effects on work environments (Peters & Brown, 2009).

Contagious diseases are among the most prevalent in the work environment (Whysall et al., 2018). With the current global concern regarding the spread of COVID-19, it is relevant to pay special attention to the possible consequences of contagious diseases in the workplace, for both employees and leaders. Studies that have examined how influenza affects workplace productivity and its relationship with presenteeism are scarcer, even though influenza is one of the most common health-related causes of presenteeism (van Wormer et al., 2017). Nevertheless, there have been a few that found associations between influenza and greater workplace productivity loss (Tsai et al., 2014; van Wormer et al., 2017). Due to regular interpersonal interactions, leaders and their employees are in permanent contact in the workplace, which can mean a greater risk of contagion (Luksyte et al., 2015).

Recent research (Chen et al., 2021; Rigotti et al., 2014; Whysall et al., 2018) has stated that influenza and psychological conditions (e.g., depression and anxiety) are the most prevalent illnesses reported in the workplace, affecting a full 21% to 59% of workers. However, most researchers who have assessed health-related issues in the workplace have tended to focus only on physical illnesses (Grawitch et al., 2017). In order to extend the existing findings (e.g., Whysall et al., 2018) and fill this gap in the literature, this current study has devoted more attention to psychological and contagious health conditions. Figure 2.1. shows the proposed model.

Health Conditions and Productivity

Presenteeism research has focused on productivity losses due to physical health problems (Grawitch et al., 2017). However, since individuals may feel more uncomfortable working with colleagues with psychological conditions than with people with musculoskeletal health conditions (Rüsch et al., 2005), the present study expected that a leader with a psychological disorder would be associated with lower levels of productivity. As proxy agents, leaders influence the properties of human agency, such as self-reactiveness and self-reflectiveness. Thus, when employees work closely with a leader suffering from a psychological condition, it is anticipated that they will have more difficulty in reflecting on their personal efficacy and in the meaningfulness of their pursuits (Bandura, 2006), resulting in lower levels of productivity.

The existing evidence confirms that contagious and psychological illnesses are more prevalent in work environments and are associated with greater productivity losses (Bouwmans et al., 2014; Goetzel et al., 2004a; Hemp, 2004; Whysall et al., 2018). Both studies 1 and 2 of this current research investigated whether leaders' psychological and contagious conditions can affect individual workers' productivity differently than physical illnesses do. Therefore, for study 1 and study 2, we developed the following hypotheses:

Hypothesis 1: When a leader presents no symptoms of an illness (i.e., the control group), individuals' productivity will be higher than that of those in groups whose leader shows health problems.

Hypothesis 2: When a leader exhibits symptoms of a non-contagious physical illness (a), individuals' productivity loss will be lower than when this leader has b) a contagious physical disease and c) a psychological illness.

Health conditions and their impact on physical engagement, emotional engagement and role ambiguity

Since this study focuses on the impact of different types of health conditions among leaders on a set of several productivity outcomes, we decided to examine two more variables in study 2, namely role ambiguity and engagement. Role ambiguity and engagement are two variables that have been studied extensively in the organizational context, and there is existing evidence that they may affect the functioning of individuals or teams (S. H. Lee et al., 2017; Ma et al., 2018a). Furthermore, these variables have also been associated with employees' poor general health (Inoue et al., 2018a), thus making them relevant to explore in the present research. Previous studies have already shown the usefulness of using social cognitive theory and its processes to understand social influence within organizations, and to look into the gaps in the literature concerning role ambiguity (Chen et al., 2013) and engagemen t(Lu et al., 2018). We extend prior research that exclusively focused on work engagement and role ambiguity at a single level, and which neglected the social influence processes that occur between leaders and employees (Lu et al., 2018), especially when dealing with the presenteeism phenomena. For the reasons reported below, we argue that leaders' presenteeism can positively affect role ambiguity levels and negatively affect the engagement levels of an entire team,

Role ambiguity has been defined as the extent to which an individual is uncertain about job performance expectations and, therefore, lacks certainty and clarity about what they should accomplish in their work (Rizzo et al., 1970; Schuler et al., 1977). On that basis, it can also be defined as a lack of role clarity, which means that when there is no role ambiguity, there is role clarity and vice-versa (Inoue et al., 2018a). A considerable amount of research has shown that role ambiguity can cause lower productivity and affect a person's ability to perform effectively (Linardakis et al., 2017; Zhou et al., 2016). Role clarity, on the other hand, has been linked to greater job satisfaction and organizational commitment (S. H. Lee et al., 2017). Role ambiguity, considered one of the major stressors at work, can also reduce individuals' psychological well-being, and meta-analytic studies have linked it to manifestations of poor physical and mental health (Jackson & Schuler, 1985). Specifically, there is evidence of the association between role ambiguity and physical illnesses, anxiety and depression(Schmidt et al., 2014). In general, recent investigations have reported that role ambiguity is associated with a greater risk of developing a set of mental health problems, contributing to poor mental health in the workforce(Inoue et al., 2018a).

In the same vein, previous investigations have also encompassed productivity losses due to presenteeism and its relationship with role ambiguity. Zhou and colleagues (2016) found that role ambiguity was negatively related with productivity associated with presenteeism. Furthermore, this research also revealed that role ambiguity mediated the relationship between supervisor support and productivity associated with presenteeism.

Moreover, role ambiguity is also negatively correlated with employee engagement (Mañas et al., 2018).

Employee engagement has been an organizational variable conceptualized in several ways, all of which include behavioral, cognitive and affective dimensions, with specific characteristics that can influence employees differently (S. H. Lee et al., 2017). As Luksyte and colleagues (2015) recommended, we explored individuals' emotional and behavioral reactions to leaders' presenteeism by analyzing physical engagement and emotional engagement. Physical engagement concerns the investment of effort, physical energy, and hard work with regard to task completion, whereas emotional engagement concerns emotional and affective reactions related to the work role itself (Luksyte et al., 2015; Mañas et al., 2018). Employee engagement has been positively associated with work ability, health, job performance and job satisfaction (Villotti et al., 2014a). Studies have indicated that employees with low work engagement have reported diminished health more often than employees with higher levels of engagement (Torp, 2012). More specifically, investigations have shown significant correlations between engagement and a range of mental and physical health issues, including symptoms of depression and minor problems, such as influenza (Robertson & Cooper, 2010; Torp, 2012). Although the literature lacks research on the impact different health conditions have on role ambiguity and engagement, we predict that compared to physical illness, influenza and depression will be associated with lower levels of engagement and higher levels of role ambiguity, since they are both health conditions associated with greater productivity losses (e.g., Whysall et al., 2018). This line of reasoning led to the following hypotheses:

Hypothesis 3: When a leader doesn't present any illness (a) or exhibits symptoms of a non-contagious physical illness (b), engagement will be higher than when the leader has a contagious physical illness (c) or a psychological illness (d).

Hypothesis 4: When a leader doesn't present any illness (a) or exhibits symptoms of a non-contagious physical illness (b), role ambiguity will be lower than when the leader has a contagious physical illness (c) or a psychological illness (d).

The mediator role of physical and emotional engagement

The relationship between role ambiguity and performance can be explained by several intermediary variables (Fried et al., 1998). However, there is still scant research that views engagement as an intervening variable between role ambiguity and performance. We assume that physical and emotional engagement have the potential to deliver a better understanding of the cognitive processes between role ambiguity and performance, especially in the presence of adverse health conditions.

Within the SCT approach, leaders can, as proxy agents, influence the collective agency (Bandura, 2006). In organizations, the idea of a generalized collective efficacy may be applied, resulting in a group perception of the general group capability to achieve performance goals. This collective efficacy involves an understanding of shared beliefs for cognitive action, such as emotional engagement and physical engagement(Fried et al., 1998). Thus, it is possible that a leader's health condition may influence whether their team can achieve collective efficacy. In terms of improving our knowledge of the intermediary processes between role ambiguity and team performance, we propose engagement as a mediator between these variables.

Several studies have shown negative correlations between role ambiguity and performance, which means that higher levels of role ambiguity have been associated with lower levels of job performance in the literature (Fried et al., 1998; Mañas et al., 2018). Similarly, there is evidence of the negative correlation between role ambiguity and engagement(Mañas et al., 2018). Regardless of the importance of role ambiguity and engagement in predicting performance, the mediating processes affecting this relationship are still unclear in the literature. To fill this gap, we identified physical and emotional engagement as intermediary processes linking role ambiguity to team performance. Empirical evidence predicts a negative relationship between role ambiguity and physical/emotional engagement, and between physical/emotional engagement and team performance. Combining these two predictions would suggest that physical engagement and emotional engagement should mediate the relationship between role ambiguity and team performance when a leader presents an illness. Based on previous evidence (Mañas et al., 2018), we proposed that there is an intermediary step in the relationship between role ambiguity and team performance: the mediatory role of physical and emotional engagement. Following this logic, we formulated the following hypothesis:

Hypothesis 5: When a leader presents an illness, individuals' emotional and physical engagement will mediate the relationship between role ambiguity and team performance.

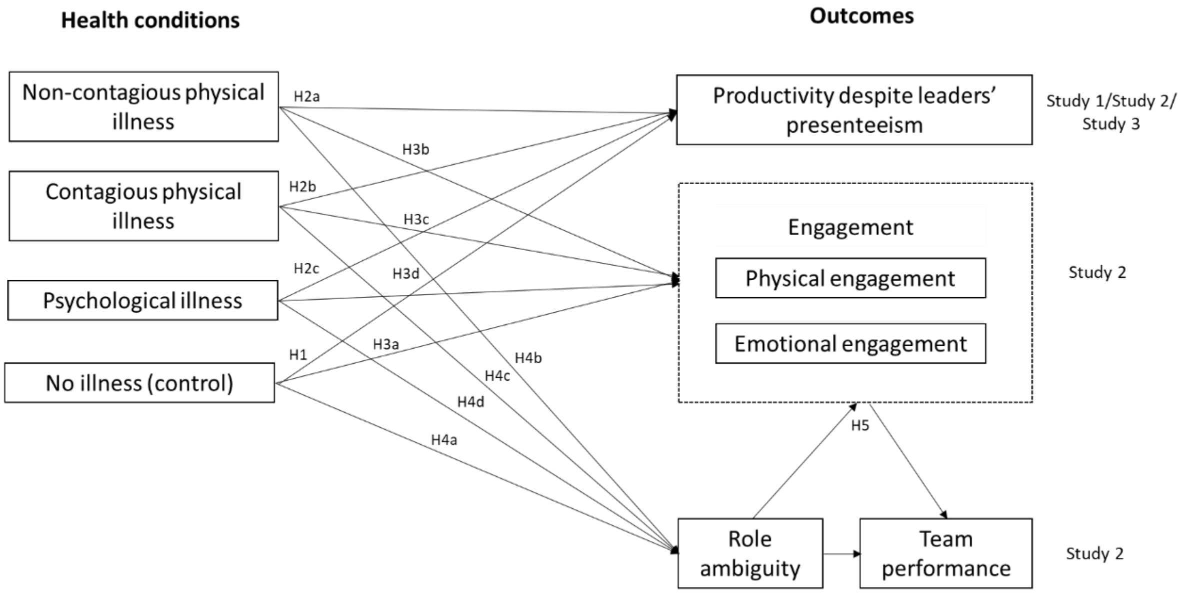

Figure 2.1. Proposed model.

Pilot Study: Scenario Validation

Because we wanted to conduct our pilot study in a classroom setting by presenting images of sick or healthy leaders to students, the images had to be previously validated to ensure their neutrality and that they accurately represented leaders with adverse health conditions. Based on the relevant literature on presenteeism (e.g., Bouwmans et al., 2014; Whysall et al., 2018), we decided to test a variety of health problems associated with higher levels of productivity losses. These included non-contagious physical conditions (i.e., arthritis, dermatitis, and allergies or sinusitis), psychological illnesses (i.e., depression and anxiety), and a contagious physical illness (i.e., influenza).

To validate the scenarios, we recruited 36 individuals - 77.8% of whom were female - with a mean age of 24.37 years (standard deviation [SD] = 4.56). The participants were given an online survey via Qualtrics Software. They were asked to evaluate leaders' health on a 7-point Likert scale ranging from 1 ("Not sick") to 7 ("Very sick"), based on an image of a healthy leader and six images representing leaders with an illness. These showed 1) a man with no illness, 2) a woman suffering from anxiety, 3) a man with influenza, 4) a woman with arthritis, 5) a woman suffering from depression, 6) a man with dermatitis, and 7) a man with allergies and sinusitis. For each image, participants were asked to imagine that the person in each image was their leader, with whom they would have to interact and be in permanent contact with at work. Next, the students were asked to evaluate whether the leader in the image was showing symptoms of one of the following health problems: influenza, allergies, dermatitis, arthritis, depression and anxiety.

The results of the pilot study confirmed that each of the seven images properly represented the expected health condition, so we were able to use them in study 1. Specifically, we performed a *t*-test comparing each specific sickness scenario with all the other health sickness scenarios, for each image presented. The results of each condition tested are as follows: influenza (mean [M] = 4.57; SD = 1.65; t [34] = 16.39; $p < 0.01$); allergies or sinusitis (M = 4.92; SD = 1.64; t [35] = 17.92; $p < 0.01$); anxiety (M = 5.31; SD = 1.56; t [34] = 20.05; $p < 0.01$); depression (M = 4.44; SD = 1.84; t [35] = 14.46; $p < 0.01$); dermatitis (M = 6.06; SD = 1.11; t [34] = 32.28; $p < 0.001$); arthritis (M = 5.86; SD = 1.17; t [35] = 29.93; $p < 0.01$).

STUDY 1

Participants and Procedures

The sample in study 1 comprised 326 students from a public university. The participants were from nine different university degree courses and belonged to 12 different classes. Most of the respondents were female (202), and both females and males were aged between 17 and 43 years (M = 20.90; SD = 2.84). Most of the sample (67.3%) reported having previous work experience, while 32.7% reported they had not yet had any kind of job. The sample was not ethnically diverse, with the students' racio-ethnicity categorized as follows: 93.5% "White," 3.7% "Black," 2.2% "Asian," and 0.6% "Other."

For each class that participated in study 1, the survey presented a leader with one of the six health conditions (flu, dermatitis, arthritis, allergies or sinus problems, depression and anxiety) or the control condition (i.e., no health problem), in a between-subject design. After students had completed the demographic questions, they were shown images of sick leaders, each with a different health condition. The students were asked to imagine that the image presented on the screen represented the leader they would have to interact with and be in permanent contact with during their first internship in their field of graduation. Then, the students were asked to evaluate a set of statements about what their productivity would be if they had to work with a leader with that specific health problem. The administration of the whole survey took approximately 10 minutes. The survey was presented either in the students' native language or in English, depending on the language used to teach each class. The English version of the survey went through a process of back-translation by a native English speaker.

Measures

Productivity despite leaders' presenteeism

In the scenarios presented to the students, productivity despite leaders' presenteeism was measured using an adaptation of the Stanford Presenteeism Scale's (SPS-6) - original version developed by (Koopman et al., 2002). The SPS-6 measures the individuals' capacity to complete their work and how they avoid distractions while performing tasks.

For the experimental condition, we asked students to evaluate this six-item scale according to their expected feelings about having to work with a leader with a specific health problem. Examples of the items include "I would feel desperate with regard to accomplishing certain tasks" and "My job would be much harder to handle". The Cronbach alpha was .79 for the six items, and construct validity suggested a Principal Component Analysis with 71.34% of the total explained variance. Since this scale refers to leaders' health conditions, the respondents completed this scale only for the sickness conditions. For the control, we adapted the same six items so that they only evaluated individuals' productivity if they had to work with a leader with no health impairment.

Transparency and openness

We describe our sampling plan, all data exclusions (if any), all manipulations, and all measures in the study, and we adhered to the Journal of Applied Psychology methodological checklist. All data, analysis code, and research materials will be made available, just simply ask the authors and the link will be sent. Data were analyzed using SPSS version 24 (IBM Corp, 2016). This study's design and its analysis were not preregistered.

Data Analysis

All analyses were conducted using IBM SPSS Statistics version 24. The data were analyzed using one-way analysis of variance (ANOVA) with a Bonferroni post-hoc test in order to determine which of the four groups (i.e., psychological illnesses, physical conditions, contagious disease, and control group-no illness) differed from each other.

Study 1 results

Hypothesis Testing

Table 1 displays a summary of the descriptive statistics. Given that the literature suggests differences between males and females regarding presenteeism outcomes (Martinez & Ferreira, 2012), gender was controlled. However, no statistically significant differences were found in this present study. In accordance with *hypothesis 1*, there were significant differences between individuals' mean productivity levels for the no illness condition (M = 3.34; SD = 0.33), and for the health conditions (M = 3.12; SD = 0.44; t [334] = 2.897; $p < 0.05$). The one-way ANOVA results revealed that the four different types of health conditions had a significant effect on individuals' perceptions of their own productivity levels. More specifically, the type of health condition had a significant effect on presenteeism (i.e., productivity despite illness) levels ($F_{[3, 321]} = 38.97$; $p < 0.01$).

Table 1.1. Descriptive Statistics for Study 1.

Variable		N	M	*SD*	Minimum	Maximum
Presenteeism	Control group	38	3.58	0.53	2.50	4.83
	Psychological conditions	68	2.84	0.63	1.67	4.17
	Physical conditions	99	3.99	0.79	2.17	5.00
	Contagious condition	121	3.38	0.68	1.17	4.83
	Total	326	3.47	0.80	1.17	5.00

Since the ANOVA cannot show which means are different, we conducted Bonferroni post hoc analyses to determine whether the health conditions groups differed from each other. According to the results, there was a statistically significant difference between the control condition of no illness, and a leader suffering from a psychological disorder (confidence interval [CI] 95% [0.365; 1.115]; $p < 0.01$). There was also a significant difference between a leader suffering from a psychological illness and a leader with a non-contagious physical illness (CI 95% [-0.935; -0.326]; $p < 0.01$), and between a leader with a psychological illness and a leader with a contagious physical disease (CI 95% [-0.820; -0.259]; $p < 0.01$). In addition, there was a statistically significant difference between a leader with a non-contagious physical condition and the control condition (CI 95% [0.061; 0.768]; $p < 0.01$), and between a leader with a non-contagious physical condition and a leader with a contagious physical disease (CI 95% [0.364; 0.867]; $p < 0.01$).

Furthermore, as *hypothesis 2* postulates, individuals' productivity was generally lower in the scenarios in which leaders had psychological (M=3.02, SD=.42) and contagious physical illnesses (M=3.18, SD=.44), and higher in the scenarios in which leaders present a non-contagious physical condition (M=3.20, SD=.41). The results confirmed that individuals perceived themselves to be less productive and thus, more strongly affected by leaders' presenteeism when they had to work with a leader who showed symptoms of psychological and contagious illnesses.

Study 1 discussion

The purpose of study 1 was to examine the relationships between leaders' health conditions (i.e., psychological illnesses, non-contagious physical conditions, a contagious disease, and a control group of no illness) and productivity despite leaders' presenteeism. We sought to understand which types of health conditions in leaders most affected individuals productivity.

The results supported our hypotheses. After comparing the means of the four health conditions, we concluded that non-contagious physical illnesses were more widely tolerated than psychological illnesses, as the former are thought to have a minor impact on productivity. In contrast, psychological and contagious physical illnesses had a greater impact on the perceived effect of presenteeism on productivity. A possible explanation for this finding is that, as mentioned previously, societies tend to stigmatize individuals with mental illness (Rüsch et al., 2005). The results suggested that people felt more uncomfortable working with individuals suffering from psychological illnesses than with people showing symptoms of physical conditions. This significant level of discomfort may generate negative emotions and unfavorable behavioral reactions at work.

Moreover, our initial findings highlighted the need to integrate mentally ill people more fully into their workplace(Peters & Brown, 2009). The results from study 1 also highlighted a need for organizations to focus on decreasing the negative attitudes that surround individuals with mental illnesses to help build healthier work environments for leaders and employees. Although these were interesting findings, our second objective was to test *hypothesis 2* in study 2, that is, to understand whether individuals' productivity would be higher when their leader presented no evidence of health conditions compared to when the leader had health problems. However, the fact that study 1 was built upon fictional scenarios could call into question the investigation's internal and external validity. To overcome this limitation, we developed study 2 in an experimental context. For this experimental study, we decided to focus on only three sickness conditions (i.e., influenza, depression and arthritis), because these were the diseases associated with lower levels of productivity.

We, therefore, replicated study 1 in an experimental study (i.e., study 2) to avoid the common method variance limitations of study 1's results.

STUDY 2

In study 2, we sought to create a constructive replication of study 1's findings with an experimental design. This design enabled us to explore further the effects of leaders' different health conditions on team productivity despite leaders' presenteeism. Our goal was to understand: whether team productivity would be higher when their leader presented no evidence of health problems than when their leader had health problems; whether a team's physical and emotional engagement with the task would be higher when their leader presented either no health problem or a non-contagious physical disease; whether team role ambiguity would be lower when their leader presented either no health problem or a non-contagious physical disease; and whether emotional and physical engagement would mediate the relationship between role ambiguity and team performance.

Methods

Sample A

Participants and Procedures

We recruited 266 students from two public universities and divided them into 68 teams. In exchange for their participation, the students were given a five-euro gift card or a movie ticket. For the three types of health conditions, we asked the respondents, "did you perceive the leader as being sick?". Following Meade and Craig's recommendations, (2012)we excluded 16 respondents who reported that the leader was not sick because they were not engaged by the experimental manipulations used in the present study. Moreover, the SPS-6 scale protocol (Koopman et al., 2002) states that individuals who did not perceive the associated health problems should not be considered for the purpose of the investigation. Similarly, in this investigation, if the participants did not perceive their leaders as sick, they are not likely to respond to a leader's presenteeism signs. This left us with a final sample of 250 students, 50.8% of whom are female, and whose mean age was 20.71 years (SD = 2.42).

In the subsequent experimental research, we followed Luksyte et al.'s (2015) suggestions and manipulated leaders' health status using assistants who acted as though they had the health conditions we were focusing on in the current study. We applied a between-subjects design in which participants were randomly assigned to three conditions. These were: a leader with a contagious physical illness (i.e., influenza); a leader with a non-contagious physical condition (i.e., arthritis); and a leader with a psychological illness (i.e., depression).

For each health condition, the assistants followed previously developed detailed scripts which had been rehearsed with each assistant in experimental training sessions. The scripts that leaders had to follow were developed to enable the maximization of the emergence of leadership characteristics. For instance, leaders should encourage the team to continue working, display support and confidence, be aware of possible mistakes and to ensure that the task goal was accomplished.

Concerning the manipulation of the health conditions - in the influenza condition, for instance, the assistants had to show these specific “sick” behaviors: coughing every 3–5 minutes, blowing their nose every 5–6 minutes, sneezing every 2 minutes, occasionally saying “this flu is killing me,” and asking for a tissue once in the middle of each experiment. For the arthritis condition, assistants’ hands were colored with a red cosmetic powder to give the illusion that the joints were swelling. The assistants were instructed to act as if their hands were stiff and weak, pretending that they felt pain when moving their hands and asking participants for help when the assistants needed to grasp objects. For the depression condition, the assistants were asked to show a set of behaviors and symptoms associated with this illness during the experiment. For example, the assistants pretended to suffer from fatigue and sleep problems (i.e., yawning several times and saying that they were having trouble sleeping) and to experience trouble concentrating and remembering details (e.g., students’ names). These assistants also showed a general apathy and lack of enthusiasm, moving or speaking more slowly than usual.

The participants were put into teams of between 3 to 5 people in each, and asked to work on an interdependent, highly engaging task, commonly known among researchers as “the marshmallow challenge”. The students had to build the highest possible tower in 18 minutes using the following construction materials: 20 sticks of spaghetti, plasticine, and one marshmallow. This task was considered appropriate for testing the research hypotheses since it required close collaboration and coordination and was relatively interesting enough to engage the participants.

The participants then answered a questionnaire that took approximately 15 minutes to complete. Because the respondents had to interact with an actor who pretended to be sick, the participants were given a short debriefing of the study's real purpose at the end of each experiment to explain that the leader's health status had been manipulated. More specifically, after working with the leader with an apparently contagious condition, the participants were told that the experiment had never put them at risk of catching influenza. By doing this, the ethical considerations of the research were guaranteed.

Qualitative Method

Sample B

To complement the data collection, semi-structured interviews were conducted with a subset of the participants (N = 26) at the end of some sessions. The majority of those interviewed were female (53.8%) and were between 19 and 29 years old (M = 21.27; SD = 2.75). The purpose of the interviews was to understand the ways in which the participants perceived their leaders' illnesses affected their performance, and what difficulties the interviewees had perceived during the experiment.

Aggregation

The level of analysis of interest in this study was the team. Therefore, all individual team members' responses were aggregated to the team level for further analysis. Each condition had the following number of teams: control condition -20 teams; contagious physical condition -14 teams; non-contagious physical condition -13 teams and psychological condition -13 teams.

Measures

Productivity despite leaders' presenteeism

As in study 1, productivity despite leaders' presenteeism was measured using the adapted version of the SPS-6. The adapted scale has a Cronbach's alpha of .87 with an explained variance of 72.41%.

Physical Engagement

The students were asked to indicate to what extent they would invest physical energy and effort in their jobs if they had to work with a sick leader (e.g., "I would exert my full effort in my job."). When measured using an adapted version - a 6-item scale by (Rich et al., 2010). The Cronbach alpha was .87 with an explained variance of 70.19%.

Emotional Engagement

This was measured using an adaptation of a self-rated emotional engagement 6-item scale by (Rich et al., 2010). The scale assesses the extent to which people experienced positive feelings about their work when they had to work with a sick leader (e.g., "I would show enthusiasm in my job."). The Cronbach alpha was .89 with an explained variance of 63.19%.

Role Ambiguity

This was measured through six items developed by (Rizzo et al., 1970), conceptualized as the lack of clarity of role expectations and the degree of uncertainty regarding the outcomes of one's role performance (e.g., "I knew exactly what was expected of me"). Higher values in this scale are associated with lower levels of role ambiguity. The Cronbach alpha was .84. with an explained variance of 45.69%.

Team Performance

This was measured with an adaptation of a 5-point Likert scale developed by Walumbwa and Avolio (2008). The three items were adapted for this study in order to measure team performance (rather than individual performance). The role-play assistant completed this scale at the end of each session, so that researchers could conduct an external evaluation of each team's performance. Examples of the items are: "In your estimation, how effectively did this team get the work done?" and "All in all, how competently did this team perform the task?". The Cronbach alpha was .93.

Manipulation Check: Health Status

As mentioned earlier, we used assistants who pretended to be sick in order to manipulate leaders' health status. This approach was previously used in the research work of (Luksyte et al., 2015). In the present study, the participants were asked, "did you perceive the leader as being sick or as having a health problem?" The participants who self-reported that they did not perceive the leader as being sick (N = 16) were excluded from subsequent analyses.

Results

All analyses were conducted using IBM SPSS Statistics version 24. Table 2 displays the descriptive statistics for Study 2. To test the effects of the leaders' three different health conditions on teams' productivity despite leaders' presenteeism, we conducted an ANOVA analysis. The results confirmed that the three illnesses had a significant impact on teams' productivity levels ($F_{[2, 141]} = 3.713$; $p < 0.05$; partial $\eta 2 = 0.05$).

Table 1.2. Descriptive Statistics for Study 2.

Variable		**N**	**M**	***SD***	**Minimum**	**Maximum**
Presenteeism						
	Depression condition	47	2.81	0.73	1.00	6.33
	Arthritis condition	47	2.84	0.62	1.00	5.33
	Influenza condition	50	2.49	0.76	1.00	3.67
	Total	144	2.67	0.74	1.00	6.33

As shown in Figure 2, a simple effect analysis revealed that, for influenza (M = 2.49; SD = 0.76) and depression (M = 2.81; SD = 0.73), participants reported lower levels of productivity than did participants whose leader had arthritis (M = 2.84; SD = 0.62). These results support *hypothesis 1*. We conducted post hoc analyses using the Bonferroni correction to determine which of the health condition groups differed from each other. Statistically significant differences were found between teams with leaders suffering from a contagious disease and teams with leaders pretending to have a non-contagious physical condition (CI 95% [-6.999; -0.0009]; $p < 0.05$). Therefore, *hypothesis 2a)* and *2b)* were accepted.

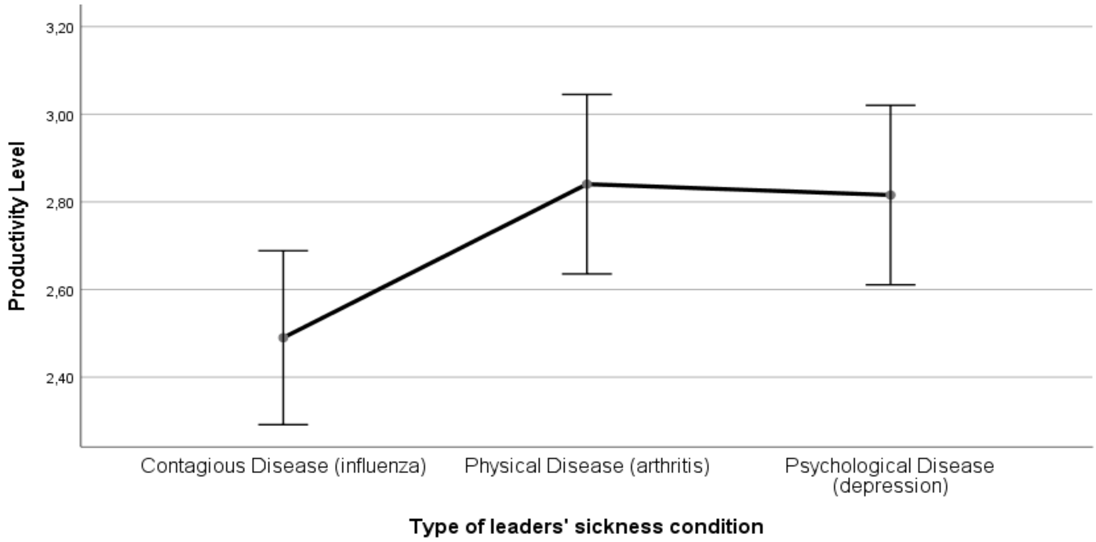

Figure 2.2. Leaders' Health Conditions Predicting Productivity level.

However, no significant differences were found between groups with leaders suffering from a psychological illness and groups with leaders acting as if they had a contagious physical disease (CI 95% [-0.239; -0.6751]; *p* = 0.07). In addition, no important differences were found between participants with leaders pretending to have a non-contagious physical illness and with leaders suffering from a psychological illness (CI 95% [-0.3301; 0.3797]; *p* = 0.98). We thus rejected *hypothesis 2c)*. In general, as postulated in *hypothesis 2,* teams' productivity despite leaders' presenteeism was lower in groups with leaders showing signs of having a psychological or contagious illness, and higher in the groups in which leaders suffered from a non-contagious physical condition, thereby partially confirming the results of Study 1.

Hypotheses 3 and *4* predicted that engagement would be higher and role ambiguity would be lower when the leader presented a non-contagious physical illness or no illness than when the leader presented a contagious or psychological illness. Regarding engagement, the results were only statistically significant for the physical engagement dimension. Consistent with that, teams reported greater physical engagement with the task in the conditions of non-contagious physical illness (M=4.08) and no illness (M=3.90), compared with teams where the leader had a contagious physical illness (M=3.59) or a psychological illness (M=3.67). Statistically significant differences were found between teams with leaders suffering from a contagious disease and teams with leaders pretending to have a non-contagious physical condition (CI 95% [-0.9237; -0.0684]; $p < 0.05$). Therefore, *hypothesis 3* was accepted.

Consistent with *hypothesis 4*, teams reported lower role ambiguity in the conditions where the leader had a non-contagious physical illness (M=5.39) or no illness (M=5.58) compared with teams where the leader had a contagious physical illness (M=5.28) or a psychological illness (M=4.84). Post-hoc analysis revealed statistically significant differences between the control and depression conditions (CI 95% [-0.0636; -1.3149]; $p < 0.05$). These results provided support for both *hypothesis 3* and *4*.

PROCESS, a macro for SPSS developed by Hayes (2013) was used to test the mediation hypothesis (*hypothesis 5*). Emotional engagement and physical engagement were examined as mediators between role ambiguity and team performance. The full model with emotional engagement included as a mediator was significant ($F_{(2,33)}$ = 32.5399, $p < .001$, $R^2 = .39$). Results revealed significant effects of role ambiguity on group performance (a path) ($b = -.8863$, $t_{(33)} = -2.8302$, $p<0.05$, 95% CI [-1.5259, -.2467]). The direct effect (c' path) of role ambiguity on group performance after accounting for emotional engagement remained significant (t (33) = 4.3940, $p < .001$, 95% CI [1.4285, 3.9098]). Although path *c'* remained significant, there was a significant indirect effect of role ambiguity on group performance through emotional engagement, demonstrated by the bootstrapped 95% CI of the indirect effect ($b = .9847$, $SE = .2755$, 95% CI [.5263, 1.5995]). The full model with physical engagement included as a mediator was not significant (F (2,33) = 0.0619, $p = .94$, $R^2 = .00$. These results suggest a partial mediation between role ambiguity and group performance only through emotional engagement, partially consistent with *hypothesis 5*.

Qualitative Analysis (Sample B)

The interviews conducted with a subset of participants provided valuable information that that facilitated a better understanding of these results. Firstly, the results overall suggest that individuals' productivity was less affected when they had to work with a leader showing symptoms of a physical condition such as arthritis, which implies difficulty using their hands in a certain way. Regarding this condition, most respondents interviewed mentioned that, because the leader had difficulty moving his hands, the students tried to work more efficiently while constructing the tower so that the leader would not have to hurt himself by helping them.

One participant said:

> I noticed that the leader wanted to help us, but he couldn't because his hands were hurting a lot. When we realized he had difficulty working, we tried to help and focus on building the tower without his assistance so that he wouldn't have to use his hands. (P7)

Another interviewee reported:

> The leader's hands were really red, and he complained that it was difficult to help construct [sic] the tower, so I tried to help more with the materials, by cutting the sticks of spaghetti myself and supporting the tower when it was not very stable. (P18)

In the groups with a depressed leader, the participants interviewed stated that their leader's behavior (e.g., apathy and a lack of enthusiasm) made them feel less enthusiastic about the construction project, causing the students to put less effort into performing their tasks. One participant shared:

> I didn’t like his attitude. He was always reinforcing that he was tired, and he was just looking at us, not helping at all or giving any tips. It made me feel that it was not that important to accomplish the task. (P24). Another participant said, “the leader interacted too little with our team. It seemed that he didn’t care about us or anything at all. He seemed sad and tired” (P25).

In the contagious illness groups, the participants revealed that they noticed the leader’s health problem and emphasized their fear of contagion. One interviewee reported:

> “his disease really disturbed me. He was always coughing and sneezing” (P3). Still another student stated, “I was afraid of being infected by him. He seemed really sick” (P12). A participant shared: “when he was sneezing, I tried to step back. I didn’t want to get the flu” (P5). Another student reported: “I know he was trying to help us, but it really disturbed me because he was always blowing his nose and then touching the plasticine with his hands” (P15).

The qualitative analyses thus provided a better understanding of the results of the quantitative data analyses. Our findings support the conclusions that individuals may react differently to leaders’ various health conditions and that psychological and contagious illnesses can have a stronger negative effect on employees’ productivity despite presenteeism.

Study 2 discussion

The purpose of study 2 was to explore the effects of leaders’ different health conditions on teams’ productivity despite leaders’ presenteeism, in an experimental design. We sought to understand whether team productivity, physical engagement, emotional engagement and role ambiguity would vary depending on the leaders' different types of health conditions. We found support for *hypotheses 1,* 3 and *4,* but *hypotheses 2* and *5* were only partially corroborated.

In general, the results confirmed that psychological and contagious physical illnesses were associated with lower levels of productivity despite leaders' presenteeism, and non-contagious physical illness was associated with higher levels of productivity, partially confirming study 1's results. Our findings suggest that the teams' physical engagement with the task was higher when the leader presented a non-contagious physical illness such as arthritis, which is possibly explained by the fact that they felt their help was more valuable with regard to accomplishing the task (since his arthritis involved difficulty with hand movements) (Tang et al., 2011). Regarding role ambiguity, a possible explanation could be that in the cases where there was no associated health problem, or a physical illness where individuals had to be more physically involved in the task, there was no lack of clarity of role expectations and no uncertainty regarding what needed to be done (Linardakis et al., 2017).

The results also suggest a partial mediation between role ambiguity and team performance through emotional engagement, which is partially consistent with *hypothesis 5*. In other words, decreased emotional engagement partially accounted for the relationship between role ambiguity and team performance. This suggests that teams who report higher levels of role ambiguity are more likely to have lower levels of emotional engagement, which in turn, leads to lower team performance.

Our results provide valuable information on the specific effects leaders' various health problems can have on team productivity despite leaders' presenteeism, engagement and role ambiguity. In line with Study 1, our results provided the first evidence that leaders with health problems could influence their employees' behavioral reactions to illnesses at work. Our findings suggest that different types of health conditions among leaders can affect work environments in distinct ways, especially through employees' lower productivity and also through some aspects associated with organizational behaviors, such as higher role ambiguity and decreased work engagement. Despite improvements to study 2 regarding internal validity (compared to Study 1), the experimental design used may raise questions concerning ecological validity. Also, the non-existence of a close relationship/previous interactions with the leader may have affected the results. To overcome this limitation, we developed study 3, with the aim of extending the findings to real-life settings.

STUDY 3

To overcome the limitation of the student population used in both studies 1 and 2, we developed a field study specifically for the working population.

Participants and procedure

182 workers (64.3% female), aged between 18 and 56 years (M = 31.12; SD = 9.12) and with an average salary of 1147€ per month (SD=986.02) responded to an online survey through Qualtrics Software. Using the workplace scenario of Study 1, we asked workers what their performance and productivity was like when they actually had to work with a leader with a specific health problem (influenza; arthritis or depression) versus no health problem. 62.5% of the participants reported they had worked at least once in the last six months with a leader with symptoms of a health problem. Specifically, 61.8% reported that their leader presented symptoms of a contagious illness; 25.7% reported that their leader showed symptoms of a psychological condition and, finally, 18.4% of the participants registered that their leader suffered from a physical health condition. 37.5%

of the respondents reported that their leader had not suffered from any health problem in the last six months, thus were excluded from the analysis. We also implemented a control group, corresponding to workers' productivity and performance when they had to work with a leader with no health problem.

Measures

Participants were asked to evaluate their own productivity with five items (ranging from 1: minimum productivity to 100: maximum productivity) relating to productivity outcomes, namely: "the ability to work faster"; "the ability to focus on work"; "the ability to finish hard tasks"; "the ability to work with as few errors as possible" and "the ability to complete work within the deadlines". These specific items were selected because they reflect the SPS-6 dimensions regarding productivity outcomes(Koopman et al., 2002), thus meeting Study 3's purposes. This measure can therefore be considered as an alternative to the one for productivity despite leaders' presenteeism, used in both study 1 and 2. Average scores for each item were posteriorly calculated and analyzed.

Study 3 results

In accordance with *hypothesis 1*, there were significant differences between workers' mean productivity levels for the no illness condition (M=77.16; SD=12.98) and the illness conditions (M=66.41; SD= 28.44; t [169] = 2.023; $p < 0.05$). The one-way ANOVA results revealed that the two different types of health conditions (illness *vs.* no illness) had a significant effect on workers' productivity levels ($F_{[1, 169]} = 4.092$; $p < 0.05$). These results are in line with the results of Study 1 and Study 2.

For *hypothesis 2* and similarly to the results of Studies 1 and 2, the One-way ANOVA revealed that the three different types of leaders' health conditions had a significant effect on workers' productivity levels. More specifically, the leaders' type of illness had a significant effect on workers ability to work faster ($F_{[3, 170]} = 3.793$; $p < 0.05$); their ability to complete work within the deadlines ($F_{[3, 170]} = 3.826$; $p < 0.05$); their ability to finish hard tasks ($F_{[2, 141]} = 3.931$; $p < 0.05$); their ability to work with as few errors as possible ($F_{[3, 170]} = 6.782$; $p < 0.05$); and their ability to focus on work ($F_{[3, 170]} = 3.143$; $p < 0.05$). However, for each item, workers' productivity was, in general, lower in the scenario in which leaders had psychological and physical illnesses and higher in the scenario in which leaders presented a contagious illness (see table 3). Therefore, results for *hypothesis 2* were only corroborated for the psychological illness condition.

Table 1.3. Productivity for each type of health condition in Study 3.

	No Illness (control condition)		**Psychological Illness (Depression)**		**Physical Illness (Arthritis)**		**Contagious Illness (Influenza)**	
	M	M	M	M	SD	SD	SD	SD
"The ability to work faster"	73.30	57.69	67.46	72.68	22.93	30.07	32.09	21.97
"The ability to complete the work within the deadlines"	72.60	59.13	69.11	74.28	23.06	28.98	32.81	17.62
"The ability to finish hard tasks"	82.00	60.52	68.98	72.62	25.02	30.18	32.54	14.07
"The ability to work with as few errors as possible"	81.37	55.17	69.33	75.26	24.86	30.53	33.84	16.49
"The ability to focus on work"	76.57	56.69	68.33	70.11	25.07	30.04	32.45	16.46

Note: N = 170

Additionally, we also asked the question "how did your supervisor's disease affect your productivity (i.e., work faster, on time, fewer errors and focus)?". The results for *hypothesis 2* are in line with the results of studies 1 and 2, which means that workers' productivity was higher when the leader had a non-contagious physical illness (M=88.08; SD=15.65), and lower when the leader had a contagious (M=83.70; SD=20.05) or a psychological illness (M=76.94; SD=20.84). Moreover, we calculated productivity costs for each illness through the monetization of the productivity losses in months and days. As shown in Table 4, the average costs of productivity loss were higher for psychological and contagious physical illnesses and lower for the non-contagious physical illness condition.

Table 1.4. Productivity, Salary & Productivity loss per month/day for Study 3.

	Psychological Illness (Depression) (N = 49)		Physical Illness (Arthritis) (N = 52)		Contagious Illness (Influenza) (N = 51)	
	M	*SD*	M	*SD*	M	SD
Productivity despite leader presenteeism	76.94	20.84	83.70	20.05	88.08	15.65
Salary (month in €)	914.57	268.98	930.90	446.88	966.92	318.97
Productivity loss (month in €)	219.70		107.72		130.75	
Productivity loss (day in €)	9.99		4.90		5.94	

Note: N = 170

Study 3 discussion

The purpose of study 3 was to analyze the effects of leaders' different health conditions on workers' productivity despite leaders' presenteeism, using a real-life scenario to overcome the limitation of using a student population in the previous studies. In line with study 1's results, we found support for *hypothesis 1* and for *hypothesis 2b.*

In general, the results suggest that when a leader is suffering from a psychological illness, workers' productivity decreases, compared to situations where the leader has a non-contagious physical or a contagious physical illness. These results confirm that a leader's mental status can lower the quality of the work environment(Gilbreath & Karimi, 2012).

Additionally, our results provide valuable information on the specific productivity costs associated with each health problem. The average costs of productivity losses were higher for psychological and contagious illnesses, which highlights the need for companies to adequately manage these types of health conditions and the subsequent presenteeism behaviors in the workplace. This evidence can help leaders understand how the way they manage their own health status can have an impact on their subordinates' productivity levels.

GENERAL DISCUSSION

This investigation explored presenteeism from a new perspective in order to assess the impact leaders have on subordinates, which has been neglected in the literature. To our knowledge, this is one of the first investigations to study productivity despite leaders' presenteeism in organizations.

The strengths of this research are its use of a mixed-method approach and study 2's experimental design. Experimental studies possess more internal validity, therefore, our results are more amenable to being generalized to real-life situations because experimental research is the most appropriate method for studies seeking to draw conclusions about causal connections. Presenteeism research has relied primarily on cross-sectional studies, which means the innovative approach taken by this current research to study presenteeism in an experimental setting is quite significant. The mixed-method approach applied also has strengths that offset the weaknesses of both quantitative and qualitative research. Using this method facilitated a more complete and comprehensive understanding of the research problem and a fuller explanation of our findings.

Theoretical Implications

The results of our research provide several theoretical contributions to the literature on leadership, presenteeism, and social influence. Firstly, we integrated the possible implications of SCT (Bandura, 1989) into the existing research on leadership and presenteeism. On a psychological level, workers' greater interpersonal identification with leaders may increase their perceived susceptibility to illness when their leaders come to work sick. Our findings are consistent with this argument, showing that leaders' health conditions affect individuals' productivity and reveal the hidden dangers of working with a sick leader (Luksyte et al., 2015). Consequently, leaders' social influence may thus play an important role in shaping employees' behaviors and productivity. These findings advance the existing knowledge about SCT and the core properties of human agency, contributing to new theoretical developments that integrate social-cognitive aspects in the field of presenteeism research. We believe this is one of the first investigations to extend SCT concepts to the presenteeism and leadership literature. In addition, this investigation is also one of the first to use proxy agents, as SCT suggests, to explain the mechanisms underlying the influence a leader's health status has on their followers and teams. The majority of prior research has only approached presenteeism from an individual agency perspective. Our study may help these issues, as we explain the social-cognitive aspects of leadership presenteeism through the use of proxies.

According to our results, there were differences concerning the type of relationship individuals had with the sick person (Luksyte et al., 2015). Closer and more frequent interactions with the leader (e.g., study 3) can be a problematic issue as far as psychological illnesses are concerned. On the other hand, if individuals had to work with a new person, with no previous social interactions between them (e.g., study 2), contagious illnesses may have been more problematic, since they could increase the risk of contagion. This can lead to the assumption that individuals' reactions to different types of health problems may be influenced by any previous social interactions and experiences they may or may not have had with the sick person, which can be a determining factor regarding their behavioral reactions to illnesses.

Secondly, research on presenteeism has, for the most part, predominately focused on the individual (Luksyte et al., 2015). In the present study we investigated presenteeism from a new perspective, by assessing the impact of leaders' presenteeism on individuals and teams, thus, contributing to the presenteeism literature. Since the consequences of presenteeism are not only restricted to those who are present (Lohaus & Habermann, 2019b), this is a refreshingly innovative way to look at the presenteeism phenomenon within organizations to determine its influence on others.

The field of presenteeism still needs to be contextualized concerning the conceptual and methodological challenges of the construct, especially with regard to measuring the act of presenteeism, as well as the associated productivity losses. This paper aimed to provide insights into these important aspects.

Thirdly, the literature on leadership has focused on the impact that leadership behaviors have on several job-related outcomes (George et al., 2017; Gilbreath & Karimi, 2012), with special attention being paid to the impact leaders have on their subordinates' health. In the present study, we concentrated on leaders' own health status, which is a revolutionary way to look at the role of leaders in work environments. Leaders are responsible for creating and maintaining a psychologically healthy work environment (Gilbreath & Karimi, 2012), but they cannot do this if the importance of their own health condition is underrated. Since presenteeism can have numerous causes, it is crucial to highlight the important role leaders' own health status plays in contributing to their teams' collective effectiveness and productivity. In light of the SCT, this study is one of the firsts attempts to establish leaders as proxy agents that can influence the surrounding collective agency. Our study can also provide new contributions to the field of leadership theories, particularly the Leader-member Exchange theory (LMX). Since LMX states that leaders influence employees through the quality of the relationships developed between them (Ansari & Jayasingam, 2013), it follows that the quality of this relationship can be affected by leaders' adverse health conditions.

Lastly, since we have not found research that has tested engagement as a mediating variable between role ambiguity and performance, there are limited opportunities to see the results of this investigation in light of previous literature. Nevertheless, similarly to previous studies (e.g., Lu et al., 2018), we introduced social cognitive theories into work engagement and role ambiguity, and our results are consistent with previous research showing the association of role ambiguity with poor engagement and lower performance(Mañas et al., 2018).

Practical Implications

Our findings also have significant practical implications for managers because managing presenteeism effectively can result in competitive advantages for organizations (Hemp, 2004; Johns, 2010). Exploring this area further could help supervisors understand how they can influence workers' productivity and help build work environments that maximize individual employees' potential and productivity.

In the current worldwide economy, there is a constant flow of products, services and people among companies and multinational brands. The high risk of infection from viruses, especially the COVID-19 virus because of its high transmission rate, is causing global alarm. Therefore, focusing on the contention of contagious diseases in the work environment is even more relevant. Appropriate infection-control measures should be implemented in the workplace. Such measures would include minimizing the chances of exposure, ensuring greater cleaning care and providing employees with relevant training sessions. Specifically, regarding influenza, the present findings also suggest a negative impact on individuals' productivity when leaders come to work with influenza, therefore, precautions need to be taken. Preventative measures should be implemented in organizations, such as seasonal flu vaccinations(van Wormer et al., 2017). Another option would be to quarantine sick leaders to curb the spread of influenza or other contagious illnesses at work.

Our results highlight the importance of motivating organizations to implement changes regarding the acceptance of mental illnesses, and to reduce the negative attitudes that surround these health conditions. The individual, societal, and organizational costs associated with workplace mental health problems currently constitute a major public health issue (Joyce et al., 2016). Managers must develop policies or create workplace programs and interventions to help reduce the stigmatization of mental illnesses in the workplace (Bhui et al., 2012). In addition, organizations can develop initiatives that not only focus on preventing common mental illnesses at work, but also facilitate the recovery of workers diagnosed with psychological disorders (Joyce et al., 2016). However, in order to be effective, these interventions must incorporate sick workers, managers, and coworkers. Managers should also encourage a work environment for people with mental illnesses where they feel respected, welcomed and supported, so that their illness may have lower impact on their engagement, role ambiguity and productivity level (Villotti et al., 2014a).

Notably, the pressures that leaders must deal with at work could have a negative impact on their health and could be conducive to some psychological illnesses, including anxiety and depression (Bhui et al., 2012). Organizations can support initiatives such as mindfulness workshops and therapies to reduce stress and anxiety to help leaders deal with job-related stress.

The findings from study 2 suggest that, in an initial approach, individuals react more strongly to leaders' contagious illnesses. This can be particularly relevant for companies whose leaders have more frequent interactions with new employees, such as at call center companies. Measures can be taken so as not foster presenteeism cultures within organizations, and to introduce measures that promote full recovery from contagious illnesses before going back to work.

With regard to arthritis, companies must develop workplace interventions to improve pain management and the functional status of workers with musculoskeletal disorders. Initiatives such as these have previously been associated with higher productivity and better job outcomes (van Vilsteren et al., 2015). To help people with arthritis function better at work, various aspects can be improved including, among others, work status, contractual working hours, and the availability of workplace support (Tang, Beaton, et al., 2011). From an ergonomic perspective, since the extent of the impact of arthritis on work is a function of the individual and how they interact with the work context, changes can be made regarding the job's demands, ensuring breaks from repetitive motions and reduced working hours (Tang, Beaton, et al., 2011). Additionally, employees should have access to chairs with lower-back support, ergonomic computer keyboards and other work equipment designed to minimize joint pain.

In general, work-related interventions can be beneficial if they specifically target each health problem and incorporate explicit work-related outcomes (Joyce et al., 2016). Companies need to develop the tools to monitor and diagnose a presenteeism climate in order to then implement measures to reduce its negative impacts on workers' performance and productivity (Ferreira et al., 2019).

Limitations and Directions for Future Research

The current study's limitations need to be considered when interpreting the above findings. First, study 1 and study 2 were conducted with a student population. Although 67.3% of the sample reported having had previous professional experience, the findings for both studies may not be easily generalized to working populations. However, study 3 was carried out specifically to overcome this limitation. Second, although an experimental design has many strengths, it also has some disadvantages, such as the possibility of human error or the creation of situations that are not realistic. However, our mixed-method approach was selected specifically to help overcome this limitation, and all these aspects were taken into account when designing the experiment. Finally, since our data were collected before the worldwide COVID-19 pandemic, the effects we found for the contagious condition could be even more evident nowadays.

Future studies could replicate our experimental design with a sample of working individuals. Researchers also need to explore other variables that can affect the relationships between leaders' health conditions and individuals' productivity, such as leadership styles. Also needed are experiments intended to better establish causal relationships between role ambiguity, engagement and productivity. The presenteeism and leadership literature would also benefit from the inclusion of the gender variable in future research, since the effects of leaders' behaviors can depend on the gender of the leader (Rigotti et al., 2014). In addition, investigations are needed to determine the consequences of leaders' health conditions in terms of other contagious and non-contagious illnesses.

Because the social influence processes in organizations occur not only between leaders and their employees, but also between coworkers at the same level, sick employees who choose to be present at work expose their close colleagues to health risks (Bokhari et al., 2017). As suggested by (Luksyte et al., 2015), future research should investigate the consequences of coworkers' behaviors that foster a climate of presenteeism at work. According to some authors (Ruhle et al., 2020), research on presenteeism should also focus on factors such as the type of illness and the specific context where the presenteeism behavior occurs. Finally, leaders' presenteeism may have different characteristics in terms of individual and group performance, so further studies would also need to consider using multi-level approaches regarding the variables that can affect the climate of presenteeism in organizations.

CONCLUSION

With its mixed-method approach and both experimental design and field settings methodology, the present research findings constitute significant contributions to the existing literature on presenteeism and leadership, and its link to SCT. This study contributes to SCT by establishing that leaders may be seen as proxy agents within organizations, and play an important role in shaping employees' behaviors and productivity. Other important findings are the significant results from studying the role that leaders play in encouraging presenteeism behaviors among their employees. This research provides valuable evidence that leaders' different health conditions can affect work environments in distinct ways, especially through employees' lower productivity, lower engagement, and higher role ambiguity. We explored presenteeism from a new perspective by assessing leaders' impact on subordinates, in a field in which most research is still dominated by a focus on individuals. In the current global pandemic context, building healthier work environments for leaders and their subordinates must be a top priority for both academics and managers.

CHAPTER 3[3]

TOWARDS A SOCIO-COGNITIVE PERSPECTIVE OF ROBOT LEADERSHIP: LEADERSHIP STYLES IN HUMAN-ROBOT TEAMS.

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[3]This work is currently under review in *Information Systems Research*, as: Lopes, S. L., Rocha, J. B., Ferreira, A. I., & Prada, R. Towards a socio-cognitive perspective of robot leadership: leadership styles in human-robot teams.

Abstract

In the near future, robots will not only be part of our lives, but will also be able to work alongside humans. Within the framework of Social Cognitive Theory, this paper explores robot leadership and the impact of human-leadership styles in teams headed by social robots. The expectation is that social robots will be capable of serving as leaders for human teams in order to improve the organizational requirements of the workplace environment. For Study 1, an experimental study was conducted to compare productivity, role ambiguity and engagement outcomes in 65 teams. Participants had to perform an organizational task with either a robot leader or a human leader. Our results show that robots can properly perform leadership roles while leading human teams, and can also achieve the same organizational outcomes as human leaders. For Study 2, the same experiment was conducted in order to determine which human-leadership styles would be associated with better organizational results. Thirty-six teams had to work with a robot acting in accordance with a leader script, which corresponded either to transformational or transactional leadership. Results showed that both transformational and transactional leadership styles can have positive impacts on different organizational outcomes. These results show ways in which robots can be successfully introduced on human teams, and also how management and artificial intelligence fields can be integrated by linking the leadership construct and social cognitive concepts to human-robot interaction scenarios.

Keywords: Human-robot interaction, Leadership, Engagement, Productivity, Social Cognitive Theory.

INTRODUCTION

Recent years have been marked by the rapid development of the artificial intelligence field and its subsequent applications in several scientific areas, including human resource management. Social robots are artificial intelligence machines which interact and communicate with humans to perform designated tasks(H. Webb et al., 2019). Within organizations, social robots are currently utilized as assistants in areas such as security, health care (Jussupow et al., 2021; Yoon & Lee, 2018)and education (Belpaeme et al., 2018). If implemented appropriately in organizations, robots can help people enjoy the potential benefits provided by technology, whatever their age or technological literacy level. Previous research has shown that individuals exhibit unique and favorable responses to physically present social robots(Samani & Cheok, 2011). This is because the ease with which they are perceived as independent agents fosters compliance and acceptance in human-robot interactions (Sebo et al., 2020a). For these reasons, it is important to investigate how groups and teams accept and are influenced by social robots.

Since robots are machines programmed to operate semi or fully autonomously, they may have the capability to perform roles increasingly similar to those performed by humans (Dang & Liu, 2021; You & Robert, 2018). While research into human-robot interaction has, over time, focused consistently on the influence of robots within groups of people, knowledge about the influence of robots at the team level is still limited. Integrating both humans and robots into successful collaborative teams could be a decisive step in an increasingly technological world. As the role of robots in the workplace evolves, research on human-robot interaction and the most appropriate allocation of roles needed for this integration is crucial (Samani et al., 2012). Recent advances in the field of human-robot interaction are causing humans to work more closely with robots and to successfully integrate them into work environments (Savela et al., 2021). Hence the urgent need to know more about how robots impact the interpersonal dynamics of teams, and how that can affect work outcomes.

In light of such developments, it is expected that social robots in the near future could have the capability to serve as the managers and leaders of human teams (Gladden, 2014), which could lead to exciting applications for the organizational environment. Indeed, some studies involving mixed human-robot teams have already demonstrated that individuals tend to favor in-group robots over out-group humans (Fraune et al., 2017), which would imply that people are favorably inclined to accept working alongside robots, and consider them as part of the team. Moreover, current research shows that in terms of shared knowledge and communication, human-robot human-robot interaction nor has been sufficiently explored by researchers in management and artificial intelligence fields. The primary focus of this paper is robot leadership, specifically teams' perceptions of leadership behaviors and the impact robots can have on teams, regarding a set of organizational variables. Furthermore, we will also analyze robot leadership in light of two of the most prominent leadership theories, namely transformational and transactional leadership. To further understand how robot leadership can be a reality in the near future and how robots can display efficient leadership roles, we will look at the practices of the leadership styles defined in human relationships, as has already been done in previous work (e.g., Howard & Cruz, 2006).

The theoretical basis of this research relies on Social Cognitive Theory (SCT). According to this theory, people perceive, interpret, and categorize their own social behavior and that of others (Bandura, 1989).Drawing upon SCT, this present investigation has three main goals. First, it seeks to explore through an experimental design, teams' perceptions of robot leadership behaviors, and evaluates the robots' influence on a set of organizational outcomes, specifically productivity, engagement and role ambiguity

(Study 1). Second, it examines the teams' perceptions of robots performing leadership roles typically associated with human leadership styles, particularly transformational and transactional leadership (Study 2). Finally, it seeks to contribute to the literature by extending social cognition literature to artificial intelligence scenarios, representing one of the first attempts to use mechanisms from SCT to explore the underlying processes of the relationship between humans and social robots. Role ambiguity, engagement and productivity are variables that have been studied extensively in the organizational context, and there is ample evidence that they can affect the functioning of individuals or teams (Lee et al., 2017; Ma et al., 2018). Efficient companies have employees who fully engage with their leaders, with their tasks and with their teams, all of which leads to better organizational results. Since those are variables that distinctly affect the work environment, this investigation aims to study them in the light of robot leadership and human-robot interaction scenarios. Simultaneously, we seek to provide evidence for the advantages of robot leadership, using theories that apply to humans as the theoretical background, specifically SCT and transformational and transactional leadership theories.

This research is innovative with regard to is its real-context human-robot interaction, whereby participants interact and share the same space with an actual robot. Since most of the existing research in this field is based on hypothetical/imaginary scenarios or non-experimental studies (Savela et al., 2021), we believe our data can help build confidence in and gain acceptance for the use of robots in work environments. Moreover, most current research conducted with social robots takes place with children in educational settings or with elderly people, leaving workplace settings, where individuals spend the majority of their time and where robots can have great influence and impact. Following recent recommendations (e.g., Sebo et al., 2020), we conducted this research in adult workplaces, in order to understand the influence robots have on work environments and also to assess workers' perceptions of social robots.

teams are similar to exclusively human teams (Demir et al., 2020). This may suggest that robots could eventually be legitimately recognized as team leaders. Prior work has also supported the assumption that the same principles that govern groups and teams of people can be applied in human-robot teams and groups (Canbek, 2019). For this reason, we theorize that social robots are able to fulfill the role of leader in teams and groups of people. We do not, however, aim to determine whether robots can be better leaders than humans, or whether or not a robot can lead human teams (although that seems to be most certainly possible). On the contrary, we seek to investigate and provide evidence of how robots can be effective leaders. Like, for example, which characteristics should robot leaders display, and do these characteristics differ or not from human leadership characteristics? In order to do so, the starting point must be to concentrate on human-leadership theoretical frameworks.

Adapting human leadership theories to the field of human-robot interaction constitutes a potential challenge that has neither been captured by recent research in

THEORETICAL BACKGROUND AND HYPOTHESIS

Extending Social Cognitive Theory to robotic leadership

Transitioning from human-leadership to robot leadership constitutes an essential change. This complex phenomenon is neither captured by current theory in human-robot interaction nor in existing leadership theories that do not currently capture how groups and teams are influenced by robots. Our work provides new insights into the unique responses teams and groups exhibit with regard to robots, in particular, robot leaders. Although there are several ways to define the leadership construct, for this paper we consider leadership to be the process of social influence in which an individual can support and inspire others to accomplish a common task, inspire others to perform to the best of their ability and take fast and decisive actions when needed (Chemers, 1997). Thus, for this investigation, we consider the robot in the role of a leader as a social agent that initiates and guides the interactions and behaviors of the team through a shared task to achieve a common goal.

As suggested by some authors (Dirican, 2015; Kolbjørnsrud et al., 2016; Samani et al., 2012), research on human-robot interaction scenarios and leadership roles are particularly valuable. Linking the fields of leadership and human-robot interaction may contribute to developing artificial intelligence technologies that can then help humans become more comfortable with social robots in work environments (Howard & Cruz, 2006).

Previous evidence suggests that some embodied characteristics in robots (such as a head and eyes) are enough to provide a group of people familiar social cues, establishing the robot as a social agent (Sebo et al., 2020a). Additionally, other research suggests that individuals engage in relational behaviors as soon as something appears to be sufficiently social (Krämer et al., 2012) and are, therefore, better able to establish effective bonds with artificial agents. Previous research has also shown that humans usually treat artificial agents the same way they treat other people, regardless of their level of familiarity with technologies (Dang & Liu, 2021). In an instinctively cognitive process, people treat robots in a social manner because individuals intrinsically interact in a social manner with others that also behave socially (Breazeal, 2000). Interaction with technological machines can be easy if social robots display rich social behavior and social feature levels similar to humans (Krämer et al., 2012). Communication and interaction processes between humans and robots do not require the acquisition of any specific competence, since humans are already sociable beings. Social robots are able to interact naturally with humans. They are equipped with capabilities that allow them to interact socially, mentally, and emotionally, just as humans do naturally (Salam & Chetouani, 2015). As stated in a recent literature review concerning robots in groups and teams (Sebo et al., 2020), human-robot interaction research has been marked by extending the principles that apply to groups entirely comprising people to mixed human-robot teams. Several studies have supported the notion that robots can fulfill the role of a human group member (Dang & Liu, 2021; Reed & Peshkin, 2008), which has led academics to consider that theories and paradigms used in human-human interactions can (and should) be employed in human-robot interaction contexts.

To this end, some effort has been made to apply SCT to the field of artificial intelligence (Henschel et al., 2020). As the nature of the relationship between humans and artificial intelligence machines has been explored by researchers, applying the concepts of SCT to the field of human-robot interaction might be useful. According to the SCT, knowledge acquisition takes place within environments where observations can be made based on social resources(Wood & Bandura, 1989b).The unique feature of SCT is its emphasis on social influence, positing that learning occurs in a social context with the dynamic and reciprocal interaction of the person, environment, and behavior. It is, therefore, plausible to consider that the same psychological process would occur when relationships are established between humans and social robots. Since social interaction is anchored in the detection and interpretation of social signs, we can assume that individuals might engage the same socio-cognitive mechanisms while interacting with a robot as in human-human interactions. For this reason, we can expect that when individuals interact with entities they lack specific knowledge of (such as artificial intelligence machines), they commonly apply human socio-cognitive processes to predict their behaviors and to explain the other entity's behavior (Marchesi et al., 2019). It has been claimed that social robots can have the potential to trigger the attribution of mental states, as long as they demonstrate signs of intentionality in their behaviors and humanlike anthropomorphism (Henschel et al., 2020). Consequently, it is possible for individuals to acknowledge and accept supervisory and authoritative behaviors from a social robot in the same way they would from humans. SCT can be a useful way to explain individuals' perceptions of robot behaviors. By applying social cognition processes to robot leadership, we can assume that perhaps we can recognize robot leadership behaviors because they behave like leaders, even though we know that they are non-conscious entities.

We argue that applying social cognition processes when we interact with robots will provide insights for a deeper understanding of the human-robot interaction processes, (especially concerning robot leadership) and contribute towards improving interactions with robots(Henschel et al., 2020). Focusing on human social cognition processes to explain interactions with social robots may lead to innovative and vital understanding in the field of human-robot interaction.

Robot leadership & organizational outcomes

Assuming that humans can accept leadership behaviors in robots, we can also propose that in organizational environments, robot leadership may influence teams and groups' organizational outputs. First and foremost, this research seeks to answer three primary research questions about whether robot leaders can achieve the same organizational outcomes as human leaders: - Can teams with robot leaders achieve similar levels of productivity as teams with human leaders? - Can teams with robot leaders achieve similar levels of engagement to teams with human leaders? And, - can teams with robot leaders achieve levels of role ambiguity similar to teams with a human leader? Study 1 will attempt to provide answers to these questions.

Introducing robots as team leaders is challenging not only from a technological point of view but also with regard to the managerial framework (Savela et al., 2021). Furthermore, it is possible that organizations will only be willing to invest in introducing robots to their work environments if that will bring competitive and productive advantages to their employees. Robot-based leadership could be useful in management and leadership tasks in many distinct ways, since robots have certain abilities (such as being able to multitask, problem solve, reason, and learn) which potentially makes for better leadership. In addition, previous studies indicate that social robots can also positively affect the dynamic of human-robot teams, influencing how the team members interact with each other (Sebo et al., 2020). For these reasons, some authors suggest that some robot capabilities might mean that robots achieve better managerial results than humans (Canbek, 2019). This is confirmed by some studies that show better team performance results when robots perform supervisory roles than when humans perform the same supervisory roles (Azhar & Sklar, 2017). Furthermore, having robots as leaders could be extremely useful in the management context, since robot leaders could be a good alternative in situations where humans have failed to lead, or even in circumstances where certain characteristics of human leaders may cause failure to achieve the organizational goals (Samani et al., 2012). Since the advances in the field of artificial intelligence are already being embraced in several scientific areas to improve individuals' quality of life, adopting the benefits of social robots in the workplace could give companies a competitive advantage.

Despite the fact that robot-based leadership can have potential benefits for employees and workplace environments, few existing studies have so far addressed these issues. Very little is known about how to enhance performance in teams working with robots on organizational tasks (You & Robert, 2018). However, grounded in SCT and the social cognitive processes whereby individuals perceive and interpret information about the social world, this present study addresses these gaps in the literature. Below, we explore the associations between robot leadership and some organizational variables that have been linked to better managerial results, namely productivity, engagement and role ambiguity.

Productivity

In general, since leaders' behaviors impact on teams' effectiveness and working processes, employee and team productivity have been linked to leadership in many distinct ways (Judge & Piccol, 2004). Having a robot as a team member, or even as a team leader can have an impact on the work done by the team (Savela et al., 2021). In fact, previous research has demonstrated that individuals' performance is improved in some tasks when a robotic agent is present, as opposed to situations with no robot present (Kuchenbrandt et al., 2013). There is also evidence that individuals work with robot partners in physical tasks similarly to the way they work with human partners (Reed & Peshkin, 2008).

Other research has shown the benefits of mixed human-robot teams (Correia et al., n.d.; Hoffman & Breazeal, 2004; Tsarouchi et al., 2017) with regard to increasing teams' productivity levels, which would indicate that humans and robots can successfully work together to achieve better productivity (Fong et al, 2001).

Engagement

Engagement refers to the behavioral, cognitive and affective dimensions that help individuals commit to their work (Othman et al., 2017). Engagement can make social robots interact effectively with humans and help them in their tasks, so implementing engagement behaviors in human-robot interaction is crucial (Rich et al., 2010). For this study, we chose a definition of engagement closer to the fields of management and organization. Given that the definition we chose comprises several dimensions (including the cognitive dimension), we consider it to be the one most appropriate to the workplace context of our research, and capable of providing useful insights regarding the social cognition processes between robot leadership and team engagement. Although engagement is considered to be as fundamental in human-robot interaction contexts as in human contexts, it has not been as thoroughly studied in human-robot interaction research (Sidner et al., 2004), particularly with regard to workplace scenarios. However, previous studies linking engagement and human-robot interaction have shown that human-robot interaction scenarios can be helpful to improve subjects' engagement levels (Anzalone et al., 2015; Corrigan et al., 2016; Winkle et al., 2018). Authors Salam and Chetouani (2015) proposed a model of human-robot engagement based on the context of the interaction. They assert that if human behaviors and emotional and mental states change according to the context they are in, then users' engagement with social robots will also depend on the context of interaction. Thus, in different human-robot interaction scenarios, such as educational, therapeutic or workplace scenarios, different dimensions of engagement may be more or less significant. A recent study conducted in an educational setting, proposed the term "productive engagement" to define the level of engagement that maximizes learning with regard to the social and task aspects of an interaction between humans and robots(Nasir et al., 2021). This term, grounded in the existing engagement literature, also encompasses the cognitive, affective and behavioral dimensions of engagement. Some other studies have focused on implicit objective markers, such as eye contact or joint attention to measure engagement levels with robots (Kompatsiari et al., 2019). To date, human-robot interaction literature has, in general, already shown evidence that individuals can become emotionally attached to robots, which leads them to become more engaged in their tasks and can help to facilitate better performance and productivity results (You & Robert, 2018).

Role ambiguity

Role ambiguity is defined as the extent to which an individual is uncertain about job performance expectations and, therefore, lacks certainty and clarity about what they should accomplish in their work (Rizzo et al., 1970). It can also be defined as a lack of role clarity, which means that when there is no role ambiguity, there is role clarity, and vice-versa (Inoue et al., 2018b). In management literature, role ambiguity typically emerges from the expectations of a higher organizational source and the way this is communicated (Beauchamp et al., 2005). Leaders' behaviors are factors that can affect role ambiguity, because the team leader is usually the primary source of role-related expectations for a particular role (Beauchamp et al., 2005). Since role ambiguity occurs when details about employees' roles are unclear, it often exists because leaders are unable to define and explain to the team members what is expected from them in each organizational task. In the same way, a leader who is able to communicate specific information regarding employees' roles and provides appropriate feedback will improve role clarity and, through this, the teams' ability to execute tasks.

Although there is insufficient literature regarding role ambiguity in human-robot interaction, previous research has shown that robots are capable of accomplishing managerial tasks because they can be programmed to present several capabilities such as problem solving, case-based reasoning skills and decision-making (Canbek, 2019;

Samani & Cheok, 2011). Given that these skills may reduce ambiguity in task performance, we considered that robot leaders and human leaders have an equal effect on team role ambiguity.

Robot leadership & leadership styles

Previous research has explored the benefits of using a social cognitive approach to clarify the underlying processes of the leader-follower relationships (Thomas et al., 2013). Similarly, within this research we considered that using social cognition to explain leaders' influence on teams can bring new insights to explain both the leadership and robot leadership phenomena. Therefore, it is our contention that since individuals are exposed to a wide variety of leaders throughout their working life, it seems plausible that they construct cognitive representations of leaders in general, as well as how leaders should behave and their unique characteristics. Thus, when interacting with robot leaders, individuals' responses will be guided by their prior cognitive representations in order to make sense of the robots' leadership behaviors. This will lead individuals to respond appropriately. Viewing leadership through the lens of SCT can be valuable to fully understand the interactive process between robot leaders and team members.

As the role of robots in the workplace evolves, research in human-robot interaction and the most appropriate roles needed for this integration is crucial (Samani et al., 2012). Previous studies have already established that robots are able to reproduce leaders' behaviors in order to execute leadership tasks (Canbek, 2019; Samani & Cheok, 2011). Both humans and robots can collaborate together in order to maximize the strengths of each and the organizational requirements of their environment.

Among the several human-leadership paradigms addressed in management literature, transformational and transactional leadership styles, are the most commonly mentioned, being part of the full-range leadership model (Bass et al., 2003). A transformational leader motivates and inspires their followers to increase their productivity to accomplish a common goal, directing their behavior toward a shared vision (Judge & Piccol, 2004). Factors such as exhibiting charismatic behaviors, intellectual stimulation and inspirational motivation have all been associated with transformational leadership (Batista-Taran et al., 2009.) A transactional leader focuses on supervision, organization and clarification of expectations, providing recognition if goals are achieved (Batista-Taran et al., 2009). Following this theoretical line, it is important to explore which leadership styles and respective behaviors are most appropriate for a robot to display. Adopting human-leadership styles in human-robot interaction scenarios can help to identify and adjust robot characteristics to specific contexts, in order to facilitate humans' acceptance of robot leaders in work environments (Canbek, 2019; Kolbjørnsrud et al., 2016). In the conventional human-leadership literature, leadership behaviors have been associated with numerous organizational phenomena such as employee productivity, role ambiguity and work engagement (Judge & Piccol, 2004; Villotti et al., 2014b).

The literature on management and leadership has been characterized by inconsistent findings regarding the impact of leadership styles on employee and team productivity. Bass and colleagues (Bass et al., 2003) stated that both transactional and transformational leadership styles can contribute to increased performance and productivity, which supports the proposition that a mixture of both leadership styles can lead to successful organizational outcomes (Bass et al., 2003; Judge & Piccol, 2004). However, several studies have associated transactional leadership with better productivity levels (Kalsoom et al., 2018; Wei et al., 2010). This can be explained because transactional leadership reflects a focus on task accomplishment, as opposed to transformational leadership which is more focused on person-based aspects (Burke et al., 2006). We foresee that through a social cognition process, team members will interpret the transformational or transactional behaviors of a robot, based on the leader's behavioral responses during the task. This will help them to establish the leader's identity, and respond appropriately.

In robot leadership, however, transformational features are less expected since characteristics such as inspiration, motivation and charisma are considered to be more 'human-like'. Thus, throughout the leadership process, productivity may be more related to team effectiveness and with the tasks' final outcome – aspects more closely related to transactional leadership components. Thus, in people with no experience working alongside robotic agents, it is expected that they will demonstrate higher productivity when their leader focuses on task characteristics, errors and providing explanations (Burke et al., 2006; Few et al., 2006a). This is because it is expected that a robot will direct their focus on results and towards being pragmatic. For this reason, we hypothesized:

H1: Team productivity will be higher in the condition where the robot acted as a transactional leader than in the condition where the robot acted as a transformational leader.

Among the variables that have been studied as affecting leadership styles, engagement is one of them (Popli & Rizvi, 2016). Although having employees who are engaged should be one of an organizational leader's top priorities (Batista-Taran et al., 2009), it is important to establish that having engaged employees is different from having productive employees. Employee engagement refers to the emotional commitment the employee has to the organization and its goals, whereas productivity is a measure of the effectiveness of an employee or team (Batista-Taran et al., 2009). Since these are two distinct constructs, they can be differently affected by leadership styles. Thus, engagement can benefit more from a transformational leadership style, and productivity can be more affected by a transactional leadership style. Again, from a social-cognitive perspective, team members will detect and interpret robot leadership behaviors, and the impact on team engagement levels will vary depending on whether they are transactional or transformational.

Confirming the assumptions that engagement may be differently affected by leadership styles, the literature has linked transformational leadership styles with higher levels of employee engagement (Popli & Rizvi, 2016). This can be explained by the particular characteristics that this leader-follower relationship presents, such as the level of commitment it engenders to the leader. Transformational leaders motivate and empower their subordinates by raising their confidence and inspiring them, which in turn fosters workers' engagement (T. Zhang, 2010). In contrast, transactional leaders tend to be action-oriented and only focused on team results, thus promoting a leader-follower relationship through contingent rewards (Judge & Piccol, 2004). Consequently, transactional leadership has been linked to lower levels of workforce engagement (Alkahtani, 2015, Gemeda & Lee, 2020; Soieb et al., 2013). In human-robot interaction scenarios, we expect to find similar results regarding the impact of the robot leadership style in team engagement, so we hypothesized:

H2: Team engagement will be higher in the condition where the robot acted as a transformational leader than in the condition where the robot acted as a transactional leader.

Role ambiguity occurs when the information required for adequate role performance in organizational tasks is insufficient (Lee & Low, 2016)Transformational leaders are expected to clarify role expectation, which can reduce role ambiguity

(MacKenzie et al., 2001). Several investigations have shown that transformational leadership behaviors are associated with lower levels of role ambiguity ((Al-Malki, 2016; Beauchamp et al., 2005; Raziq et al., 2018). Contrastingly, transactional leadership characteristics are more associated with focus on effectiveness, are less flexible and use punishments to encourage compliance with the rules. Such features may induce higher levels of uncertainty and ambiguity, which can increase team role ambiguity (MacKenzie et al., 2001). Moreover, a few studies have found no association between transactional leadership and role ambiguity (MacKenzie et al., 2001; Raziq et al., 2018). Taking into consideration SCT, the dynamic interaction between the team, the robot's leadership behaviors and the environment will influence team role ambiguity levels differently, depending on which leadership style the robot is following.

Since several studies have confirmed that transformational leadership style is associated with lower levels of role ambiguity (Lee & Low, 2016; Raziq et al., 2018; Soieb et al., 2013), the following relationship is expected:

H3: Team role ambiguity will be lower in the condition where the robot acted as a transformational leader than in the condition where the robot acted as a transactional leader.

The field of human-robot interaction has examined people's behaviors towards robots, such as how they socially interact (Dang & Liu, 2021). Among the different aspects of social interaction with robots, an individual's trust in them is key to facilitating success in human-robot interaction scenarios (Williams et al., 2020). A lack of trust and willingness to interact with artificial intelligence machines may make people reluctant to use technological agents (Riedl et al., 2014). Previous research suggests that individuals express more positive attitudes toward robots and trust them more when they seem to have good communication capabilities (Dang & Liu, 2021).

Since transformational leadership is characterized by inspirational, motivational and intellectual stimulation, and taking into account individual considerations (Dartey-Baah, 2015), we expect to find higher levels of human-robot trust associated with the transformational leadership style:

H4: Teams will show higher levels of human-robot trust in the condition where the robot acted as a transformational leader than in the condition where the robot acted as a transactional leader.

STUDY 1

In Study 1, we applied an experimental design in two distinct samples (human leader vs robot leader) to primally analyze whether robot leaders would be capable of achieving the same organizational outcomes as human leaders regarding team productivity, engagement and role ambiguity.

Method & Materials

Sample

We recruited 201 subjects and divided them into 65 teams of 3 to 5 members each (M= 3.09, SD = 1.15). The participants were 55.6% male, with a mean age of 26.12 years (SD = 10.51).

Aggregation

The level of analysis of interest in this study was the team. Therefore, all individual team members' responses were aggregated to the team level for further analysis. This resulted in 29 teams for the human leader condition and 36 teams for the robot leader condition.

Procedure & Task

The experiments began with all the participants signing the consent form. Next, the researcher introduced the human leader or the robot leader, explained some general guidelines, and answered participants' questions. It was emphasized that to succeed in the task, participants should follow the leader's instructions. They were also told they could interact with the leader. Then, the teams began the session with their designated leader while the researcher observed from a table in the same room but some distance away. Thus, the whole session, under both conditions, could be witnessed in a non-participant observation.

Participants were asked to work on an interdependent, highly engaging task, commonly known among researchers as "the marshmallow challenge" (Cook & Olson, 2006). The teams were tasked with building the highest possible tower in 18 minutes using the following construction materials: 20 sticks of spaghetti, plasticine, and one marshmallow (Figure 1). This task was chosen because it replicates the dynamics used in organizational scenarios, where teams have to work together to achieve a common goal(Howard & Cruz, 2006). Additionally, it was considered appropriate for testing the research hypotheses since it requires close collaboration and coordination with the team leader, and is relatively interesting enough to engage participants. After the task, the participants then answered a questionnaire that took approximately 15 minutes to complete.

The scripts

Prior to the experiment, detailed scripts were developed for each condition (human leader or robot leader). The scripts were developed to enable maximization of the emergence of leadership characteristics, as described in the literature (Bass et al., 2003).

To help to build the scripts, nine critical situations were previously established. These corresponded to the nine moments during the task that the leader - robot or human - would have to intervene. The nine situations were: a) introducing and explaining the task; b) in the first few minutes of the task, when the team is building the tower foundation; c) when the team is finishing the foundations and making them stable; d) halfway through the allotted time, to give support for executing the task; e) halfway through the time, to give support while the tower is being built and reinforced; f) to give support when the team is building the intermediate floors of the tower, focusing on adding height to the tower; g) to give support and focus attention when/if the floors are unstable and collapse; h) when the team is building the top of the tower; and i) in the final stage, focusing on making the top of the tower stable and completing the task in the time remaining. For instance, leaders should encourage the team to continue the work, display support and confidence, be aware of possible mistakes and ensure that the task goal is accomplished.

In addition to this, the literature on leadership behaviors was carefully analyzed in order to produce utterances that would completely reflect each of the leadership behaviors the leaders had to demonstrate. For each one of the nine situations described above, a set of 2 to 4 sentences was developed, with each sentence being substantiated in the corresponding literature. This gave us about 20 possible utterances that the leader (human or robot) had to say in order to support, influence, guide and inspire the team to perform at the highest level and to accomplish the task goals.

The human script and the robot script were similar in content since the behaviors of the human and robot leaders had to be consistent with one another to ensure that each leader's performance would be as comparable as possible with regard to how they maximized their team's performance (Howard & Cruz, 2006). Additionally, for the human leader condition, those leaders had a training session in order to practice the required behaviors.

The robot

For the robot leader condition, the script was used to program the robot to act in accordance with it. The robot used in this research was an EMYS, a social robot with a control system designed to simulate some human mind functionalities, and thus work autonomously. The EMYS has a head and no body, it is able to move its head, to speak and to use some facial expressions to connect with users. The robot was designed specifically for human-robot interaction experiments. However, it needs to be assisted by a human, in a "Wizard of Oz" paradigm. This method involves simulating autonomy by means of a human 'wizard', who controls features of the robot's behavior, such as its speech. This paradigm has also been previously applied in studies on leader-follower relationships, although in different scenarios with different research goals (see van Zoelen et al., 2020). Thus, although participants were under the impression that the robot leader was fully autonomous, it was in fact controlled by the researcher in the room. The aim was that the participants would not realize this. The university's ethics commission approved the use of human-robot interaction in this experiment. The participants received no reward or any compensation.

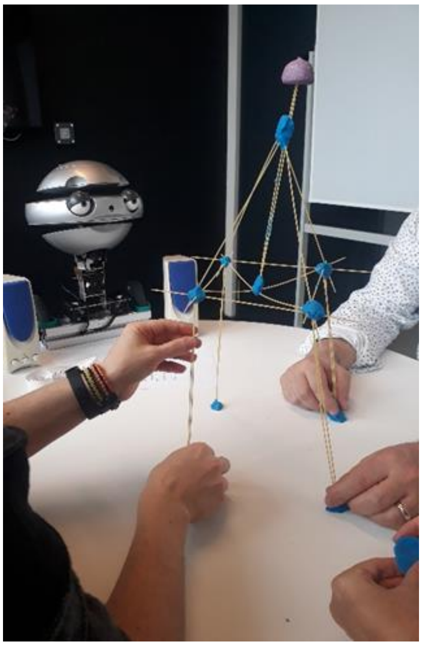

Figure 3.1. Interaction captured during a group session, where the team is performing the task following the instructions of the robot leader.

Measures

Overall team productivity

The height of the tower (in centimeters) at the end of the time available to perform the task was utilized as a measure of the overall productivity for each team.

Team engagement

Team engagement was measured on a 12-item scale (Rich et al., 2010) designed to measure two global dimensions of the Engagement construct, namely Emotional Engagement and Physical Engagement. Emotional Engagement assesses the extent to which people experienced positive feelings about their work in the assigned task (e.g., "I am proud of my work") and Physical Engagement assesses to what extent they invested physical energy and effort in their task (e.g., "I have devoted a lot of energy to my work."). The Cronbach alpha was .90 for the 12 items. The construct validity suggested an Exploratory Factor Analysis with 54.74% of total explained variance.

Role Ambiguity

This was measured through six items developed by Rizzo and colleagues (1970). It measures the lack of clarity of role expectations and the degree of uncertainty regarding the outcomes of one's role performance (e.g., "I knew exactly what was expected of me"). All items on this scale are reversed, which means that higher values on this scale are associated with lower levels of role ambiguity. The Cronbach alpha for the six items was .88. The construct validity suggested an Exploratory Factor Analysis with 61.99% of total explained variance.

Study 1 results

All analyses were conducted using IBM SPSS Statistics version 25. A one-way between subjects ANOVA was conducted to compare the effect the type of leader (human or robot) had on the height of the towers constructed by the teams. The type of leader had a significant effect on the height of the towers for the two conditions [F (1, 63) = 37.671, p < .001]. On average, in the presence of a human leader the teams built higher towers (M= 69.3, SD=19.5) than in the presence of a robot leader (M= 43.9, SD=15.4).

Significant effects were found between the type of leader and the engagement level reported by the teams [F (1, 63) = 6.871, p <.001]. On average, in the presence of a robot leader, teams reported higher levels of engagement (M= 4.28, SD=.32) than when the leader was human (M= 4.18, SD=.42). Teams also reported more role clarity in the robot leader condition ((M= 5.64, SD=.74) than in the human leader condition (M= 5.43, SD=.71). However, no significant effects were found between the type of leader and the level of role ambiguity reported by the teams [F (1, 63) = 1.975, p >.005]. These results show that robots can lead human teams in the same way as human leaders, and they also contribute to better organizational outcomes.

Study 1 discussion

Grounded in Social Cognitive Theory, and in response to calls regarding the impact of robots at the team level in organizations (Sebo et al., 2020a), for Study 1 we conducted an experimental study to compare a set of organizational outcomes in teams led either by a human leader or a robot leader.

Our results showed that in certain conditions, robot leadership has a more positive impact on teams than human leadership does. First, team engagement levels were higher in the robot leadership condition, which means that subjects allocated more effort and energy to the task when headed by a robot leader. These findings indicate that robot leadership can contribute toward increasing team engagement levels to the same extent as a human leader. This means that human-robot teams can promote better management outcomes in organizations. Moreover, our findings show that with regard to overall team productivity, working with a robot leader is related to reduced performance. A possible explanation could be peoples' lack of experience working alongside robotic agents, as this could make them perform worse (Few et al., 2006b). Role ambiguity was shown to have no significant impact in both conditions, which can be explained by the nature of the task teams had to perform (both conditions had the same allotted time, the same rules and the same materials with which to perform the task) (Amilin, 2017).

These results show the way forward for the successful introduction of robots into human teams, since they demonstrate that robots can properly perform leadership roles to lead human teams, and additionally, can also achieve the same organizational outcomes as human leaders. Our findings suggest that the level of engagement is a critical element to working with human-robot teams. Despite these relevant findings, it is also crucial to investigate further questions regarding leadership styles in robotic agents and which human-leadership characteristics robots should present. Study 2 sought to answer these issues.

STUDY 2

Since Study 1 asserts that robots can achieve the same organizational outcomes as human leaders, for Study 2 we focused exclusively on robot leadership and the several unanswered issues regarding leadership styles. Can robots perform human-leadership styles in team-interaction scenarios with the same results as if only humans were involved? Which human-leadership related characteristics are desirable for a robot leader to have?

To answer this, in this second experiment the same set of organizational outcomes and human-robot trust levels were assessed in two distinct scenarios where the robot was performing two human-related leadership styles (transformational leadership style or transactional leadership style).

Method & Materials

Sample

The sample comprised 108 collaborators from three Portuguese companies, divided into 36 teams of 3 participants each. The respondents were 52.8% females and 47.2% males, aged between 21 and 66 years ($M = 37.40$; $SD = 11.09$). The average of seniority in the companies was 8.02 years. The majority of the participants (49.1%) reported to have a university degree and 39.8% reported to have a master's degree.

Aggregation

Just as in Study 1, the level of analysis of interest in this study was the team. Therefore, all individual team member's responses were aggregated to the team level for further analysis, resulting in 19 teams for the transformational leadership style condition and 17 teams for the transactional leadership style condition.

The Scripts

For this experiment, while the same script as that used for the robot leader condition in Study 1 was applied, it was developed specifically for each leadership condition (transformational leadership style or transactional leadership style). Each script was devised to enable maximization of the emergence of the characteristics of a transformational leader or a transactional leader, as described in the literature (Bass et al., 2003). A Multi-factor Leadership Questionnaire (Rowold, 2005) and Global Transformational Leadership scale (Carless et al., 2000)were carefully scrutinized in order to produce utterances that would completely reflect each leadership style behavior that the robot had to demonstrate. For each of the nine situations, a set of sentences was developed, with each sentence being substantiated in the corresponding literature. For instance, in situation A (introducing and explaining the task) the sentence "I will give you support and ideas so we can build the highest tower together" for the transformational leadership style was inspired, developed and substantiated by Carless and colleagues (2000, p.396) and the sentence "communicates a clear and positive vision of the future". The corresponding sentence for the transactional leadership style "I will make sure that you accomplish the goal of building the highest tower" was inspired, developed and substantiated by the sentence: "I tell others the standards they have to know to carry out their work" (Rowold, 2005). Table 1 shows some examples of the script sentences that were developed for each leadership condition.

Finally, the scripts were validated by six researchers and academic professors from the fields of organizational behavior and human resource management. A moderate degree of agreement was found between the six raters. The average ICC measure was

.447, confirming that both scripts properly reflected each leadership style. Then, the scripts were used to program the robot to act in accordance with it.

Table 2.1. Example sentences for each leadership style.

Transformational Leadership style	Transactional Leadership style
"I will give you support and ideas so we can build the highest tower together."	"I will make sure that you accomplish the goal of build the highest tower."
"Let's move forward team, I trust your work, we are being efficient."	"Let's move forward team, you have to be efficient to accomplish the task."
"We're on the right direction, I'm really enjoying our performance".	"'You're on the right direction, but more effort is needed team".
"We had a good performance, I'm very proud of our work team."	"You managed not to have many errors, the goal was accomplished team."

Procedure

For the experiment, a researcher set up the robot and the materials before the teams entered the room. All the participants signed a consent form and then proceeded with the experiment. The researcher introduced the robot, explained the task rules and answered participants' questions. It was emphasized that to successfully complete the task, participants should follow the leader's instructions.

Similarly to Study 1, participants were asked to work on "the marshmallow challenge" task (Cook & Olson, 2006). The teams began the session with the robot, and the researcher stayed at a distant table in the room, from whence all the interaction could be observed and the robot could be remotely controlled. The researcher chose the robot utterances in real-time during the experiment, through a laptop containing the wizard-of-oz program. During the experiment the researcher selected the most suitable script sentences for the robot to display for each moment that occurred during the task. Finally, once the task had been accomplished and the tower constructed, each participant answered the questionnaire and was thanked for their participation.

The robot

As in Study 1, the robot used in this research was an EMYS. The university's ethics commission approved the use of human-robot interaction in this experiment.

Measures

Overall team productivity

Similarly to Study 1, for each team, the height of the tower (in centimeters) at the end of the time available to perform the task was used as a measure of each team's overall productivity.

Team Engagement

Team Engagement was measured on the same scale as in Study 1 (Rich et al., 2010). The Cronbach alpha was .91 for the 12 items, with an explained variance of 52.77%.

Role Ambiguity

Role ambiguity was measured on the same scale as in Study 1 (Rizzo et al., 1970). The Cronbach alpha for the six items was .84 and the construct validity suggested an Exploratory Factor Analysis with 60.78% of total explained variance.

Human-Robot Trust

Human-Robot trust was measured using an adapted version of the Human-Robot Trust Scale by Schaefer and colleagues (2016). From the original 40 item-scale, only 25 items were selected according to their relevance to the purposes of this research. Items were preceded by the question "What percentage of the time did the robot leader…(…)"

followed by a list of the 25 items (Schaefer, 2016). In accordance with the author, the scale was administered directly following the interaction with the robot. The Cronbach alpha was .91 for the 25 items, with an explained variance of 78.07%.

Manipulation check: robot automatization and leadership styles

As mentioned earlier, the EMYS robot needs to be assisted by a human, in a "Wizard of Oz" paradigm. For the experiment to be successful, however, it is important that the teams perceive the robot's performance to be as spontaneous as possible. Each participant was asked to answer on a 7-point Likert scale the extent to which they perceived the robot's performance as being totally spontaneous (1) or controlled by the researcher in the room (7). The average response rate was 2.40 (SD=2.2), which means that the manipulation succeeded (the participants perceived the robot to have been spontaneous).

In a similar manner, the team perception of the robot leadership style was also verified to determine whether the participants perceived the robot to be acting as a transformational leader or as a transactional leader in each condition. To measure each leadership style, participants responded to a scale adapted by Carless and colleagues (2000) that measures transactional and transformational leadership styles on a 5-point Likert scale. In the transformational leadership condition, participants reported an average rate of 3.96 behaviors perceived as transformational (SD=.66) compared to 2.95 behaviors perceived as transactional (SD=.59). In the transactional leadership condition, participants reported an average rate of 3.92 behaviors perceived as transactional (SD=.46) compared to 2.95 behaviors perceived as transformational (SD=.59). There were statistically significant differences between the conditions [F (1, 34) = 11.864, p < .005], which means that the manipulation of the robot leadership style was successful.

Manipulation check: perception of the robot as a team leader

In the questionnaire, participants were asked a manipulation-check question regarding the extent to which they perceived the robot as a team leader (1) or a teammate (10). The average response was 4.08 (SD= 1.79) which indicates that, in general, participants perceived the robot as a team leader.

Study 2 results

All analyses were conducted using IBM SPSS Statistics version 25. A one-way between ANOVA was conducted to compare what effect the robot's leadership style (transformational or transactional) had on the height of the towers constructed by the teams. The leadership style had a significant effect on the height of the towers for the two conditions [F (1, 34) = 4.240, p < .005]. On average, when the robot acted as a transactional leader, the teams built higher towers (M= 49.29, SD=14.46) than when the robot acted as a transformational leader (M= 39.16, SD=14.98), confirming *hypothesis 1*. There were also significant effects between the leadership style presented by the robot and the engagement level reported by the teams [F (1, 34) = 7.075, p < .005]. On average, in the presence of a transformational robot leader, the teams reported higher levels of engagement (M= 4.40, SD=.28) than they did in the transactional leadership condition (M= 4.14, SD=.31). These results are in line with *hypothesis 2*. Teams also reported higher levels of role ambiguity in the transactional leadership condition ((M= 5.49, SD=.66) compared to what they reported for the transformational leadership condition (M= 5.77, SD=.80). Although these results are in accordance with the direction of *hypothesis 3*, no significant effects were found between the type of leadership style and the level of role ambiguity reported by the teams [F (1, 34) = 1.363, p =.251]. Regarding the human-robot trust scale, results revealed that the teams reported higher levels of robot-trust in the transformational leadership condition (M= 59.98, SD=13.21) than in the transactional leadership condition (M= 54.93, SD=10.28). However, these results are not statistically significant [F (1, 34) = 1.609, p =.213] thus, we did not find support for *hypothesis 4*.

Study 2 discussion

In Study 2, we used an experimental design to study the relationship between human-based leadership styles and robot leadership. By adopting a human-leadership paradigm, it was possible to assess which robot-leadership approaches would be associated with better organizational outcomes. Our results showed that in human-robot interaction contexts both transactional and transformational leadership behaviors can have positive impacts on distinct organizational outcomes. This is in accordance with the human-leadership literature which states that mixing these two leadership styles is the most appropriate way to meet the demands of a more technological work environment (Bass et al., 2003; Dartey-Baah, 2015; Howard & Cruz, 2006).

Role ambiguity was shown to have no significant impact in either condition, which could be explained by the nature of the task the teams had to perform. Since both conditions had the same time limit, the same rules and the same materials with which to perform the task, they already had a set of information regarding what they were expected to do, which can explain the absence of differences (Beauchamp et al., 2005).Human-robot trust was also shown to have no-significant results, which can be explained by some of the robot design factors (such as verbal communication, facial expressions, automatization) that have been linked to the development of trust in robots (Schaefer, 2016). Teams also only had thirty minutes to interact with the robot leader, which might also explain the results, since individuals may need more time to establish a relationship of trust with artificial agents (Schaefer, 2016).

In general, these results shed some light on the matter and should be useful with regard to the possible introduction of human-related leadership styles in teams headed by robotic agents.

GENERAL DISCUSSION

The world is gradually moving forward toward a society where robots will be able to work with humans in work environments, working in collaboration to help human teams accomplish greater organizational results. To our knowledge, this is one of the first investigations to study robot leadership and robot leadership styles with human teams in an experimental setting. In light of our findings, we believe that this paper provides new directions toward integration of the fields of management and artificial intelligence through linking the leadership construct to human-robot interaction scenarios. Moreover, this study's findings constitute robust evidence that adopting human paradigms (such as social cognition and transformational and transactional leadership styles) to use in human-robot interaction can provide favorable collaborative scenarios between humans and social robots, as previously theorized by academics (Krämer et al., 2012).

Theoretical & practical implications

The results of our research extend previous findings from SCT and its implications with regard to the interaction between robots and humans. Our results reveal that, as already explored by previous researchers, social cognitive processes can be extended to human-robot collaboration scenarios (Henschel et al., 2020). In the experimental setting we developed, the interaction between the robot leader and the human team made it possible to maximize the benefits of some organizational outcomes. This could indicate that humans apply similar social cognitive processes when interacting with robots to those they use when interacting with other humans. Additionally, it also makes several theoretical contributions to the literature on management, leadership and human-robot interaction. First, our findings are in line with previous research that states that individuals can properly recognize leadership roles in robots (Azhar & Sklar, 2017; Dirican, 2015; Samani et al., 2012), and also achieve the same organizational outcomes as human leaders. Furthermore, our results advance the existing knowledge by assessing the relationship between robot leadership and some of the most important organizational variables, such as productivity, role ambiguity and work engagement. This contributes to new theoretical developments that integrate management-related aspects of leadership in the field of human-robot interaction. Specifically, managers should pay attention to engagement aspects in robot leadership scenarios.

Second, this study extends findings from previous research on the benefits and advantages of robot-based leadership (Samani & Cheok, 2011). Our results demonstrate that team productivity was higher when the robot exhibited transactional leadership behaviors. This is consistent with prior studies that report the benefits of transactional leadership in productivity outcomes (Kalsoom et al., 2018). To enhance workers' performance and productivity, robot leadership interventions should place more emphasis on adopting transactional leadership characteristics such as, paying attention to errors, task accomplishment and contingent reward systems (Bass et al., 2003). Higher levels of engagement were reported when the robot acted as a transformational leader, which is in accordance with previous studies conducted in exclusively human scenarios (Batista-Taran et al., 2009; Popli & Rizvi, 2016; Zhang, 2010). In order to achieve greater work engagement, robot leaders should demonstrate transformational leadership characteristics, such as being motivational, inspiring, and able to build confidence and empower their followers (Judge & Piccol, 2004). Given the rising number of technological agents used in numerous contexts, human-robot interaction cannot fail to take into consideration people's well-being and trust when working alongside social robots. For robot leadership to become a reality in organizations, a collaborative and reliable relationship must be built between social robots and the organizational agents (Samani et al., 2012). Although the current findings are consistent with SCT and the theoretical background of leadership, it might be premature to assume that all human theories can be applied in human-robot interaction scenarios, given the particularities of human contexts and also the robotic machines.

This study can be useful to organizations considering adopting social robots in their work environments. Essentially, the main issue is to decide how to implement new technologies (such as social robots) in an organization (Tunç, 2020). The implementation process should be managed by considering psychological and cognitive aspects of human-robot interaction. Several configurations of robots can be programmed in order to maximize the best features of each leadership style, which can be a major advantage of robot leadership since human leaders cannot be programmed in the same way (Watson, 2017).

Limitations and Directions for Future Research

The current study's limitations need to be considered when interpreting the above findings. Our results should be carefully examined, because we did not check whether participants had any previous experience working with robots. The research team did, however, have reason to believe that it was indeed a first human-robot interaction experience for all the employees who participated in the experiment. The teams also interacted and worked with a robot on one single task. It would be interesting to analyze the impact of robot leadership on organizational outcomes in a longitudinal study. As suggested by some authors, perceptions of the relationship with robots tend to evolve over time, in particular concerning trust issues(Sebo et al., 2020a). Thus, effort should be made to understand the process of developing a long-term relationship with an artificial agent, and its implications with regard to SCT (Bullington, 2009). Understanding human-robot trust across team members in real organizational settings should be the focus of future research in the field of human-robot interaction, with the variables that can affect this relationship being controlled. More studies should be developed in order to create meaningful work experiences with robots. Future studies should adopt new approaches to studying the relationship between robot leadership and its organizational outcomes, in order to enhance human-robot collaboration in workplaces scenarios. Additionally, future research should also seek to determine which factors can improve productivity and performance in teams headed by a robotic agent. Combining each leadership style in order to optimize the benefits of the human/robot workforce must be the focus of future studies in the field of robot leadership and human-robot interaction (Watson, 2017). Likewise, one of the forthcoming challenges for research on human-robot interaction must be to provide robots with the capacity to choose when to use each leadership style when interacting with human teams. We see this as a promising line for future investigation.

Future research should also keep in mind the target population that robots are designed for, as well as the purpose of the human-robot interaction (Henschel et al., 2020). Robots developed to work with older adults should present different social cognitive characteristics from those of robots developed to work with children or with young employees. It would also be interesting if subsequent robot leadership studies were to evaluate the influence that cultural differences have on people's attitudes toward working with robot leaders. Previous research has shown that the bond between humans and artificial intelligence machines is stronger in asian countries than in western countries (Kaplan, 2004), so future research should recruit data from different countries to analyze cross-cultural differences in robot leadership.

Finally, future research should also introduce robots with more human-like features than those of the EMYS, since recent studies have shown that inducing anthropomorphism in robots changes how humans think and behave toward them (Yuan & Dennis, 2019).

Despite the clear strengths of the Wizard-of-Oz method applied in this research (such as enabling the robot to have a wider range of sophisticated actions in its interactions with the teams), which make it possible to generate significant contributions to the study of robots interacting with groups and teams, it does have some limitations. Accordingly, future studies should focus on autonomous robots that can better simulate how robots will interact with people in non-research environments(Sebo et al., 2020a).

CONCLUSION

Taking our findings overall, this study complements and extends previous robot leadership literature, as well as proves through an experimental method that positive organizational outcomes can result from introducing social robots in workplaces. Furthermore, this work makes important contributions to the existing literature on Social Cognitive Theory and its subsequent applications, that go beyond exclusively human interaction scenarios. This study also has several implications for the literature on management and leadership by establishing that social robots in leadership roles can bring positive organizational outcomes to companies. Robot-based leadership will have a promising future in the years to come, and the upcoming technological developments may be applied to create more effective work environments. As more complex robots are being developed, it is fundamental to maintain focus on investigating the unique value that robot leadership can bring to workplace settings, and on how individuals and teams perceive their new artificially intelligent partners.

CHAPTER 4[4]

SOCIAL ROBOTS AS HEALTH PROMOTING AGENTS: AN APPLICATION OF THE HEALTH ACTION PROCESS APPROACH TO HUMAN-ROBOT INTERACTION AT THE WORKPLACE.

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Abstract

Technological innovations may have the potential to improve health behavior interventions at the workplace. Using a robot as a health communicator who interacts with target individuals may be sometimes superior to human change agents. Embedded in a health behavior theory that accounts for motivational and volitional processes, an innovative study has been designed to explore operating principles and intervention effects in the domains of dietary habits, tobacco consumption, physical inactivity, and stress and anxiety. A single-arm intervention with two assessment points in time, one month apart, has been conducted with 37 employees. They were confronted with a robot that delivered a supportive interaction with the study participants addressing one of the four behavioral domains. The intervention content was pre-tested and inspired by the health action process approach (HAPA). Self-report measures of all social-cognitive constructs such as self-efficacy, outcome expectancies, risk perception, behavioral intentions, and planning were applied. Pre-post comparisons confirmed the assumption of improved scores on motivational and volitional outcome variables. Moreover, mediation analyses underscored the pivotal role of behavioral intentions that translated motivational antecedents into volitional outcomes. The intervention study highlighted the innovative potential that robots may have when it comes to design theory-based health promotion strategies at the workplace. Moreover, results also confirmed basic assumptions of the health action process approach.

Keywords: health action process approach; social robots; health intervention.

INTRODUCTION

The Health Action Process Approach (HAPA) is a social cognitive model that aims to describe, explain and modify individuals' health behaviors (Schwarzer, 1992, 2008). The model was conceived as a framework to conceptualize health self-regulation as a process that can be divided into stages, in which several psychological constructs enable individuals to improve their health and well-being (Schwarzer & Hamilton, 2020). It has been used for several applications, such as: to improve fruit and vegetable intake (Domke et al., 2019; Kreausukon et al., 2012); to promote oral health (Scheerman et al., 2020); and to improve adherence to the influenza vaccination (Ernsting et al., 2013).

With the growth and establishment of Industry 4.0 and greater interconnectivity through the use of phone calls, e-mail, video calls, mobile applications, and also the rise of social robots, telemedicine has nowadays become a valuable resource. A previous meta-analysis by Webb and colleagues (2010) reported good results for internet-based interventions that can change health behaviors. Another investigation has shown that such mechanisms may assist with healthcare in several other ways, such as in diagnosis, treatment and administrative applications (Davenport & Kalakota, 2019). Following this trend, in the context of advanced technology driven interventions, it could be valuable to combine the HAPA model with communication technologies. Indeed, some technological health interventions (e.g., Rollo & Prapavessis, 2020; Scheerman et al., 2020) have already been successful in promoting change in health behavior through the use of the HAPA. However, these types of intervention frequently suffer from not being sufficiently personalized and not focusing on individuals' needs and specific goals (Hekler & Rivera, 2018). However, despite the recent advances in the field of human-robot interaction, there is still scant knowledge regarding technological interventions using social robots as health-promoting agents. This study, therefore, uses a social robot (the EMYS robot) as a social agent in the workplace, its role being to plan and help individuals improve their health status. The aim is that interaction with the robot can prompt behavior change in individuals, so that over time they can improve their general health status and, consequently, their productivity in the workplace. The use of social robots as health-promoting agents has several advantages that are clearly recognized in the literature. For instance, qualitative studies have demonstrated that people may feel more comfortable discussing health- related issues with robots because they are perceived as nonjudgmental (da Silva et al., 2018). They are also very patient, which reduces individuals' stress and encourages openness (Breazeal & Cynthia, 2011). Providing personalized counseling sessions that result in behavior change can help individuals make better health choices for their lives. In this way, the use of social robots in the workplace can contribute towards preventing presentism and loss of productivity, and could possibly lead to increased productivity in organizations, enabling the creation of healthier workplaces.

THEORETICAL BACKGROUND AND HYPOTHESIS

The HAPA model and Social Cognitive Theory

Lifestyle risk factors such as sedentarism, poor dietary habits, tobacco consumption and stress and anxiety are among the major causes of chronic ill-health, such as heart disease, cardiovascular disease, diabetes, cancer, and obesity (Schopp et al., 2014). While these represent higher costs for the healthcare industry, such lifestyle risk factors are also the ones that are easier to intercede in and prevent (Cancelliere et al., 2011). One of the questions that arises is why people do not adopt behaviors that they know are good for their health and vitality? This may be because individuals face barriers that prevent them from engaging in health behaviors, and some of these barriers may derive from the work itself (Mazzola et al., 2017). An employee's job can have a substantial effect on intentions and behaviors, even when related to matters of health. Workplaces can create an environment which either encourages or detracts from the adoption of health behaviors (Parkinson, 2018). A previous study identified workloads and time constraints as the most common barriers employees mentioned as preventing them from engaging in healthy dietary and exercise habits (Mazzola et al., 2017).

The subsequent health-related productivity costs and burdens for companies have created a need for investment in interventions that promote health and well-being in order to build a workplace culture of health (Schopp et al., 2014). Health promotion interventions in workplaces can minimize health hazards and promote workers' health and wellness. Providing employees with health education, allied to continuous feedback, can be a successful strategy for not only promoting employee health, but also for reducing the risk of more serious health problems in the near future (Cancelliere et al., 2011). Furthermore, in a post-pandemic world, organizations should engage in improving their workers' health-related outcomes, in order to strengthen and maximize flourishing work environments.

While several types of health-related interventions can be employed in organizational settings, interventions that use socio-cognitive mechanisms have been shown to be the most effective (Keller et al., 2016). Creating health-enhancing environments, through the implementation of interventions that build on psychology and new technologies can improve employee health and well-being (Parkinson, 2018). Healthy employees are productive employees, hence these types of health-related interventions are also expected to contribute towards minimizing the phenomena of presenteeism and absenteeism, both of which lead to serious costs for organizations (Ammendolia et al., 2016; Schultz et al., 2009). With this investigation, our purpose is to contribute to all of that. Thus, in this health promoting intervention, we focus on four conditions associated with a higher possibility of developing chronic ill-health: poor dietary habits, tobacco consumption, physical inactivity and stress and anxiety (Schopp et al., 2014).

Social robots as health-promoting agents

Recent advances in the field of human-robot interaction are causing humans to work more closely with robots and to successfully integrate them into work environments (Savela et al., 2021). In addition to several other technological advances in the field of healthcare (Carboni et al., 2022), the use of social robots has come into the ascendant as a new and promising kind of tele-medicine interface, mostly because of their ability to engage with individuals along several dimensions on both social and emotional levels (Breazeal, 2000). For this investigation, we follow the definition of social robots presented by the authors Bartneck and Forlizzi (2004): *"a social robot is an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact"*. Its social attributes may provide individuals with a helpful experience, one that is entirely tailored to their personal needs and goals. Social robots can be used to motivate, coach, educate, provide feedback and social support, and improve adherence to programs designed to change health behavior (Breazeal, 2011). Compared to other technologies, such as smartphone applications, computers, or screen-based avatars, their ability to interact and communicate with people provides certain unique advantages (Breazeal, 2011).

While the use of social robots able to assist and guide individuals to change health behaviors can provide greater flexibility in tele-medicine practices, it is a field to which little attention has thus far been paid (Sarma et al., 2014). Social robots can have the potential to serve as tools to improve individuals' well-being, and consequently, their productivity at work. A previous meta-analysis with a focus on robotic therapies for children and the elderly suggested that social robots, by providing comfort and coaching, can be used as a complementary tool (Costescu et al., 2014). In this way, since social robots can establish personalized and affective relationships with users, they can also be used in adult populations, to help them meet specific targets and achieve mental and behavioral goals. Another meta-analysis involving the use of social robots in mental health and well-being interventions, revealed valuable differences in patients' mood and quality of life levels, after interactions with robots (Scoglio et al., 2019).

However, little is known about social robots' potential to improve to individuals' health and well-being in working populations. This investigation is an attempt to fill this gap by focusing on the potential to use a social robot as a health-promoting agent within work environments. Such use of those machines in workplaces could be applied to tackle the difficulties (such as a lack of economic and human resources) faced in human-led well-being interventions. Social robots as health-promoting agents could also increase awareness and help workers focus on their health-related issues, which could act as a preventive measure for companies to have at their disposal. Recent investigations (Axelsson et al., 2021) have already demonstrated that people respond positively to interventions using robots as well-being coaches. In this recent qualitative study, researchers found that individuals consider that robots could be useful in providing a visual reminder to engage in healthy behaviors, and motivate people to focus on their health-related issues.

The use of social robots can be an effective way to give personalized health feedback to employees, bringing awareness to behaviors that can influence health outcomes. If implemented well, they can become an important disease prevention tool to promote healthy lifestyles within individuals in organizations (Robinson et al., 2021). Previous research has used social robots in sessions designed to encourage people to increase their physical activity (Fasola & Mataric, 2013) or improve their dietary habits (Robinson et al., 2020). This shows that social robots can positively influence people to think about health behavior changes. A previous investigation in a clinical setting also demonstrated that using robots to promote awareness and provide health education can be an effective tool in achieving health-related outcomes in such key health factors as diet, physical activity, alcohol and cigarette use (Robinson et al., 2021). Moreover, some authors stated that in health-related activities, individuals are more willing to accept recommendations from robots which, once acted upon, is then reflected in better task-related outcomes (Breazeal, 2011). Another study concerning dietary behaviors reported that participants reduced their consumption of high-calorie food and drink after an intervention with a social robot; this result is similar to the results achieved by a preliminary group using a human agent (Robinson et al., 2020). However, most studies with social robots do not track health outcomes over multiple sessions or time, as they are usually developed in single-one contexts (e.g., Robinson et al., 2021), which may lead to a poor view being taken of using robots as health-promoting agents. In this study, we aimed to develop a longitudinal intervention, involving multiple sessions and multiple interactions with the robot.

The health action process approach (HAPA) and Social Cognitive Theory

The theoretical background for this research is provided by the HAPA model, developed by Schwarzer (1992, 2008). A model figure can be found on figure 4.1. This model suggests that the adoption, initiation, and maintenance of health behaviors all result from motivational as well as volitional processes. In particular, it accounts for social-cognitive predictors that operate when translating intentions into behavior (Ernsting et al., 2013). And, whereas risk perception, action self-efficacy, and outcome expectancies are supposed to influence goal-setting, planning and coping self-efficacy are supposed to influence goal pursuit (Luszczynska & Schwarzer, 2015).

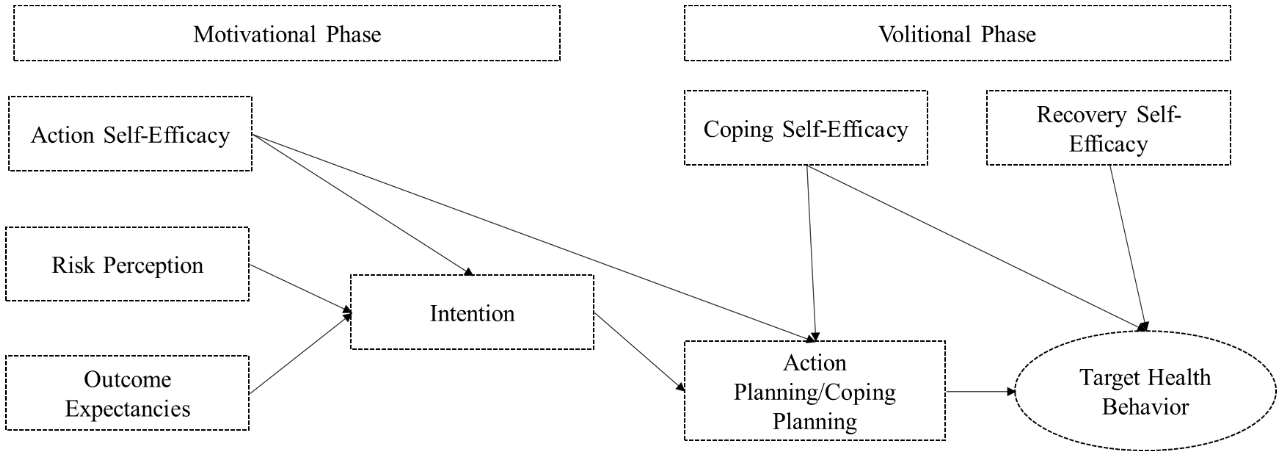

Figure 4.1. The Health Action Process Approach (HAPA; Schwarzer 1992, 2008)

The HAPA framework derives from the Social Cognitive Theory (SCT), developed by Bandura (2000), utilized to explain the adoption, initiation, and maintenance of health behaviors. The HAPA framework adapts and extends two key constructs of SCT, namely self-efficacy and outcome expectancies (Luszczynska & Schwarzer, 2015). According to SCT, these two concepts influence goal setting and goal pursuit, being related to the adoption of health-promoting behaviors and to behavioral change (Luszczynska & Schwarzer, 2015). However, HAPA was designed to extend in particular the goal pursuit phase, by taking into consideration other predictors, such as planning, maintenance, and recovery (Schwarzer & Renner, 2000). The unique feature of this model is that explicitly accounts for social-cognitive predictors that operate when translating intentions into behavior (Ernsting et al., 2013).

Some other investigations have previously used the HAPA in workplace interventions. For instance, Ernsting and colleagues (2013) applied it to encourage adherence to a worksite flu vaccination program. Furthermore, additional research that has applied the health action process approach to predict or modify sedentary behaviors in work environments has shown good results post-intervention (e.g., Prem et al., 2021; Rollo & Prapavessis, 2020). However, despite this evidence, most current research that applies the HAPA model is conducted using elderly people or students, or takes place in educational settings (Zhang et al., 2019). And yet, surely the ideal place for HAPA interventions would be where individuals spend the majority of their time, namely the workplace environment. Consequently, following recent recommendations concerning the use of robots in the workplace (e.g., Sebo et al., 2020), we conducted this research in workplaces.

HAPA key-constructs

The HAPA approach is designed to be a process that can be divided into phases in which distinct psychological constructs work together to encourage individuals to adopt health behaviors (Schwarzer & Hamilton, 2020). Together, these constructs and the subsequently proposed mechanisms, constitute the theoretical framework of the HAPA. These constructs are: intention, risk perception, outcome expectancies, self-efficacy, action planning, and coping planning. Intention is conceptualized as a predictor of action planning, coping planning, and behavior (Zhang et al., 2019). Risk perception concerns the extent to which individuals perceive a health threat, regarding their personal risk or susceptibility to particular health dangers. However, it is in itself insufficient to develop a motivation to change, unless other variables are present (Schwarzer, 2008). Outcome expectancies, which reflect beliefs about the benefits or costs that people expect to experience from adopting the behavior or not, are good predictors of intentions (Zhang et al., 2019). Self-efficacy concerns individuals' beliefs about their personal ability to exercise control over their behavior, even when confronted with potential barriers or challenges (Schwarzer & Hamilton, 2020). It has also been confirmed as a predictor of planning (Zhang et al., 2019). Planning can be divided into action planning and coping planning. These are theorized as proximal determinants of behavior, and are expected to ensure that behavioral intentions are translated into actual behavior. Action planning refers to a task-facilitating strategy that assists people in identifying cues that can lead to action, such as when, where, and how one intends to perform the behavior (Zhang et al., 2019). In turn, coping planning involves anticipating potential barriers that may appear in the process of the adoption and maintenance of the behavior, and generating plans to manage or overcome them (Schwarzer, 2008).

Our aim was to test the efficacy of a theory-based intervention aimed at promoting health behavior change among employees of organizations, delivered exclusively by a robotic agent. In this investigation, therefore, we tested intention as a mediator between risk perceptions/self-efficacy/outcome expectancies (the motivational phase) and action planning/coping planning (the volitional phase). With intention being a mediating factor in health behavior change, it is considered a critical step between the initial stage of goal setting (motivational phase) and the subsequent stages of goal pursuit (volitional phase). Following recommendations (e.g., Zhang et al., 2019), we are interested in contributing to the research on the HAPA by analyzing variables that intervene between the motivational and volitional phase.

We believe this will make an important contribution because, despite strong evidence that applying the HAPA theoretical model is highly relevant with regard to achieving health behavior change in adult populations (Ernsting et al., 2013; Prem et al., 2021; Rollo & Prapavessis, 2020), hardly any of the studies in the literature have specifically addressed the HAPA model being applied in working populations. This is even more relevant when we focus on the use of artificial intelligence machines, such as social robots, to promote healthier behaviors among employees. Aiming to overcome this gap, we developed a longitudinal design with two assessment points over a three-month period to test a series of predictions inspired by the HAPA framework.

Aims and Hypotheses

This longitudinal intervention study aimed to investigate the utility of a social robot with regard to promoting health behaviors in organizational settings, a possibility that has not been explored until now. By applying the concepts of the HAPA model, this study uses an artificial intelligence machine as a tool to achieve health behavior change among a sample of workers; interaction with the robot was designed to assess a key-modifiable risk behavior for each participant and to provide personalized feedback throughout the sessions. We first hypothesized:

H1: The HAPA-based self-regulatory factors are expected to be higher at Time 2 than at Time 1.

In addition to the above stated aim, we are interested in contributing to the body of research that tests the HAPA in health contexts, by expanding currently available knowledge concerning the effect of potential mediators on the relationship among the variables in the model. To do so, we particularly test intention as a potential mediator between the constructs of the motivational phase and the constructs of the volitional phase. As suggested by previous research (Schwarzer & Hamilton, 2020), the concept of intention has been considered an intermediate critical moment between the initial stage of goal setting and the subsequent stages of goal pursuit. For these reasons we hypothesized:

H2: Intention mediates the effect of outcome expectancies on action planning *(a)* and coping planning *(b).*

H3: Intention mediates the effect of risk perception on action planning *(a)* and coping planning *(b).*

H4: Intention mediates the effect of self-efficacy on action planning *(a)* and coping planning *(b).*

METHODS

Participants

Forty-two participants, recruited from two Portuguese organizations, were invited to participate in a health promotion program. Before the study began, the research team sought and obtained written consent from the participants. Ethical approval was obtained from the ethics committee of the university involved in the investigation. Three participants dropped out during the sessions and two did not complete the final assessment at Time 2, resulting in a final dataset of thirty-seven participants. Their ages ranged between 22 and 52 years old (*M*= 37.06; *SD*= 9.16). 78.4% of the sample were women and 21.6% were men. The majority of the participants were married (37.8%) or living in a non-marital partnership (29.7%). In terms of academic qualifications, the sample group is highly qualified – 54.1% reported to have at least completed an academic degree. 86.5% also reported having a permanent contract with the company.

Materials - EMYS robot

The robot used in this research was an EMYS, a social robot with a system designed to simulate some functions of the human mind. The EMYS has no body, but it does have a head that can move; it can also speak and make some facial expressions to better connect with users. The robot was designed specifically for human-robot interaction experiments. An image of the robot can be found in Figure 4.2. The EMYS does, however, need to be assisted by a human, in a "Wizard of Oz" paradigm. This method involves simulating autonomy by means of a human 'wizard', who controls features of the robot's behavior, such as its speech. This paradigm is commonly applied in interventions in the field of human-robot interaction, although in different scenarios with different research goals (e.g., Dziergwa et al., 2018; Paradeda et al., 2019). Thus, although the robot was in fact controlled by a researcher, the aim was that participants would not realize this and believe it was fully autonomous. The university's ethics commission (code 69/2019) approved the use of human-robot interaction in this experiment. The participants received no reward or any compensation.

Figure 4.2. The EMYS robot used in the present investigation.

Intervention design and content

The timeline for the intervention is shown in Table 3.1. During the baseline assessment, each participant was given the chance to choose a health-related behavior they wanted to focus on during their participation. There were four options: physical activity, nutrition habits, tobacco consumption, and stress/anxiety. Afterwards, in the first session with the robot, participants had the chance to confirm or modify the health-related focus of their participation. Participants' distribution over the four conditions was as follows: physical activity (n=13), nutrition habits (n=11), tobacco consumption (n=3), stress & anxiety (n=7).

Each participant had eight sessions with the robot agent over eight weeks (one session of 20-30 minutes per week). Due to the impact of the COVID-19 pandemic, all the sessions occurred in a videoconference format, via Microsoft platform Teams. All the sessions were recorded, with the participants' consent.

The intervention targeted multiple behavior change techniques that mapped onto the constructs in the motivational and volitional phases of the HAPA model. Participants were guided to set goals, monitor their behavior, elaborate action plans and coping plans and increase their self-efficacy by watching videos and testimonials.

Specifically, throughout the eight sessions, the robot agent targeted the following constructs: outcome expectancies (e.g., the robot encouraged the individuals to formulate their own potential pros and cons of the health behavior change); self-efficacy (e.g., instructions were given and effective behaviors were role-modelled); risk perceptions (e.g., the robot gave information about the existence of health risks); social influences (e.g., the robot asked individuals to demonstrate support for their co-workers who were also engaged in the intervention); action planning (e.g., individuals were asked to make concrete plans of when and how they should perform the health behavior, using the if-then formulation); coping planning (e.g., individuals were asked to identify barriers and possible solutions by making coping plans); and action control (e.g., the robot provided a digital calendar for individuals to monitor and point out (daily or weekly) the times they practice the health behavior). A table with the complete list of actions related to the HAPA model and its operationalization can be found in Appendix A. In addition to this, at the beginning of each session the robot discussed with the participants what they had done to follow their plans since the last session, and provided appropriate feedback.

Quality control measures

Engagement with the investigation

In interventions dealing with health-related issues, participants' wholehearted engagement with the purpose of the investigation constitutes a major issue (Hamilton et al., 2018). The ultimate purpose of this type of intervention is not only to improve individuals' health, but it is also to generate results that can contribute to a more positive research environment and to clinical outcomes that can lead to improving populations' overall health. This being so, and given the longitudinal nature of this intervention, it was also important to consider not only participants' level of engagement but what their motivation was for engaging with the purpose of the investigation.

Engagement with the investigation was measured using the *Patient Engagement in Research Scale* (PEIRS), a scale of 14 items measured from 1 (strongly disagree) to 5 (strongly agree). An example item is "The project was worth the time I spent on it". The mean score for this scale was 4.37 (SD=.49), which reveals that participants showed very good levels of engagement with the investigation.

Perception of the robot

Measuring humans' perception of social robots is crucial for their acceptance. In this research, we applied the *Godspeed Questionnaire* (Bartneck et al., 2009), comprising the measurement of five key-concepts in human-robot interaction: anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety. The five sub-scales of the Godspeed questionnaire utilise semantic differential scales to evaluate attitudes towards robots. In semantic differential scales, respondents are asked to indicate their position on a scale between two bipolar words (e.g., "artificial"- "humanlike"). Semantic differential scales can be converted to Likert scales ranging from 1 to 5, with higher values suggesting greater acceptance of robots. The descriptive statistics for each sub-scale were as follows: anthropomorphism (M= 2.95, SD=.70); animacy (M= 3.17; SD= .74); likeability (M=4.45, SD=.59); perceived intelligence (M=4.16, SD=.78); perceived safety (M=2.63, SD=.58). These mean scores are similar to those found in other human-robot interaction investigations, where higher mean scores are typically found for the likeability and perceived intelligence dimensions, and lower scores for the anthropomorphism and perceived safety dimensions (e.g., Correia et al., 2019; Syrdal et al., 2013; Tahir et al., 2020). In general, the five sub-scales of the Godspeed questionnaire revealed that participants showed good levels of acceptance of robots.

Assessment tools

All assessments listed below were self-report measures that were completed online in response to emails that included links to the surveys. This approach allowed participants to complete them in their own time to reduce research burden, and meant the assessments were both independent of the research team and separate from the intervention with the robot agent. All measures were assessed prior to the intervention (Time 1) and one month after the intervention (Time 2). At both times, all measures presented satisfactory internal consistency (Cronbach's α ranging from 0.75 to 0.99, see table 2).

Measures of the HAPA constructs

All measures of the HAPA constructs were based on those presented in previous research (Renner & Schwarzer, 2005). Intention was measured using a 7-point Likert scale ranging from 1 - don't intend to at all, to 7 - Strongly (e.g., "I intend to live a healthier life"). Outcome expectancy was assessed on a scale scored on a 4-point Likert scale ranging from 1- not at all true to 4- exactly true (e.g., "If I exercise regularly…that will mean an increase in life quality for me."). The items were adapted according to the conditions - nutrition, physical activity, and tobacco consumption. Risk perception was measured through 10 items and scored on a 7-point Likert scale ranging from 1- very unlikely to 7- very likely. Five items concerned absolute risk perception for the self, and the other five items concerned absolute risk perception for peers (e.g., "How likely is it that at some time in your life, your cholesterol level will be high?"). Self-efficacy was measured by a set of 12 items adapted according to all four conditions i.e. the ones mentioned above plus stress & anxiety/burnout (e.g., "I am sure that…I can change to a physically active lifestyle."). The items were scored on a 4-point Likert scale ranging from 1- not at all true, to 4 - exactly true. Action planning was measured with two items, adapted for each of the four conditions (e.g., "I already have concrete plans…how often to exercise."). The responses were rated on a scale ranging from 1- not at all true, to 4 - exactly true. Similarly, coping planning was measured with three items, adapted for each of the four conditions (e.g., "I already have concrete plans… what to do if I miss an exercise session.”). The responses were rated on a scale ranging from 1- not at all true, to 4 - exactly true.

Pre-test of the videos

In order to diversify and dynamize the materials presented during the sessions, in two of the sessions participants were shown videos that reflected some of the HAPA concepts, such as outcome expectancies, role modeling and self-efficacy. First, several search term combinations were selected to search for online videos: health + nutrition/ improving + dietary habits; tobacco consumption + health consequences/ tobacco + steps to quit; health + physical activity/ improving + exercise habits; stress + consequences/ anxiety + stress + health issues.

A group of individuals then watched the selected videos and, for each video, answered six single-item questions from a pre-test questionnaire developed on Qualtrics software. Their responses ranged on a scale from 1 (“strongly disagree”) to 10 “strongly agree”). The six items were: “the content of the video was impressive”; “this video made me think about my own health”; “after watching the video, I may have the intention to change my exercise habits”; “after watching the video, it is essential for me to do something to improve my exercise habits”; “I think the video is appropriate to warn about the risks of physical inactivity”.

The sample for the pre-test questionnaire comprised 41 individuals, aged between 19 and 55 years old. The sample distribution for each condition was: nutrition (ten individuals); exercise (eleven individuals); tobacco (ten individuals) and stress & burnout (ten individuals). The majority of the individuals had a bachelor’s degree (37.2%), or a master’s degree (30.2%). The mean scores for each video were carefully analyzed and then, for each condition, the video with the highest mean score was selected to be presented during the stipulated sessions with the robot: nutrition habits (M= 7.81, SD=1.71); physical activity (M= 6.56, SD=1.65); tobacco consumption (M=6.70, SD=2.02); stress & anxiety (M=7.70, SD=1.53).

RESULTS

All analyses were performed using SPSS (version 26). Correlations among the variables can be found in Table 3. Our first hypothesis predicted that the HAPA-based self-regulatory factors (self-efficacy, risk perception, outcome expectancies, intentions, action planning and coping planning) were expected to be higher at Time 2 (post-intervention) than in Time 1(pre-intervention). A paired sample *t*-test was performed for each of the HAPA constructs, and statistically significant differences were found between both times in the following constructs: action planning (M_{t1} =2.41, M_{t2} = 3.28, $t_{(32)}$ =-4.700, p<.001, d=1.06); coping planning (M_{t1} =1.97, M_{t2} = 3.00, $t_{(32)}$ =-6.347, p<.001, d=.93); self-efficacy (M_{t1} =3.03, M_{t2} = 3.30, $t_{(27)}$ =-2.058, p<.005, d=.69) and intentions (M_{t1} =4.98, M_{t2} = 5.65, $t_{(22)}$ =-2.377, p<.005, d=1.35). We did not find statistically significant differences in the mean scores for outcome expectancies and risk perception across the two assessment points in time, so the results only partially support our first hypothesis.

Mediation analysis

The mediation models were analyzed using structural equation modeling (Arbuckle, 2006). The six mediation models were tested separately. The type of condition was added as a covariate, given that it might influence the results of each mediation model. Three criteria should be met to support mediation effects: (1) the independent variables (outcome expectancies/risk perception/self-efficacy) should be significantly associated with the outcomes (i.e. action planning and coping planning) (path "C"); (2) the dependent variables (i.e. action planning and coping planning) should be significantly associated with the potential mediator (i.e. intentions) (path “A”); and (3) the change score of the mediator effect on the outcomes should be significant. Following recommendations from Shrout and Bolger (2002), a non-parametric bootstrapping approach was used, and the *p*-value was calculated in order to test the significance of the indirect effects. The mediating effect was considered significant when zero was not contained in the 95% bootstrap confidence interval.

Table 4 illustrates the results obtained in the mediation analysis. It was considered partial mediation when those in which both direct and indirect effects remain significant, and total mediation when only the indirect effects were significant (Preacher & Hayes, 2004). Thus, while the mediation of H2*b* is partial, in the remaining cases they were considered total.

Our results verified that the indirect effect between outcome expectancies and action planning through intentions is significant and positive (β= .018, p<.001), supporting H2*a*. However, for H2*b* both indirect and direct effects remained significant, which reveals a partial mediation (β= .023, p<.001). We also found support for total mediation models concerning H3*a* and H3*b*. Specifically, the indirect effect between risk perception and action planning through intentions is significant and positive (β= .130, p<.001), as too, is the indirect effect between risk perception and coping planning through intentions (β= .017, p<.001). Finally, for H4*a* and H4*b* total mediation models were found, which means that the indirect effect between self-efficacy and action planning through intentions was significant and positive (β= .054, p<.001), and so was the indirect effect between self-efficacy and coping planning through intentions (β= .095, p<.001).

DISCUSSION

This longitudinal intervention has examined the role of a social robot as a health-promoting agent in organizations. The main focus of the study was to test the HAPA psychological processes that occur between the motivational and volitional phases and, more specifically, the role of intention as a mediator of the relationship between goal setting (risk perception/self-efficacy/outcome expectancies) and goal pursuit (action planning and coping planning). As hypothesized, intention was found to be a significant mediator between motivational and volitional phases. This is in line with previous research that stated intention as a mediator to overcome the motivation-behavior gap (e.g., Schwarzer, 2008, 2016). The intervention with the social robot also enabled improvement of all the HAPA psychological constructs between Time 1 and Time 2, which indicates that when properly implemented, social robots can be used as social agents capable of improving individuals' health and well-being. Below, we explore in more detail the theoretical and practical implications of this research.

Theoretical and practical implications

The results of our research extend previous findings from the health behavior change literature and their application in the context of technology-driven interventions.

In addition, this research goes a step further and applies the HAPA model innovatively in the context of interaction between robots and humans. It also contributes to the field by following recent recommendations to test intention as an important variable in the HAPA model relationship and effects (Schwarzer & Hamilton, 2020; Zhang et al., 2019). This study demonstrated that the intervention resulted in significant improvements in all the HAPA constructs, and that intentions are a good mediator between the constructs of the motivational phase and the constructs of the volitional phase. Specifically, higher intentions were related to the larger effects of motivational constructs on volitional constructs. This indicates that intention can be an intervening variable in the HAPA model, which means that outcome expectancies, self-efficacy and risk perception predict action planning and coping planning via intention. These findings are in accordance with the results of a recent meta-analysis review showing that self-efficacy, outcome expectancies and risk perception can predict behavior through intention (Zhang et al., 2019). Furthermore, our findings go beyond previous meta-analytic research that showed only small-to-medium-sized correlations between intention and behavior (Sheeran & Webb, 2016).

Thus, these findings are useful in that they provide researchers and managers with information regarding what key processes to focus on when applying health behavior change techniques within organizations. Given that little is known about the efficacy of social robots with regard to influencing individuals' adoption of healthy behaviors (Sarma et al., 2014), this study also provides a new understanding in this context. This study also expects to set the agenda for future research with regard to addressing further application of the HAPA model to human-robot interaction scenarios.

What practical recommendations can we derive from our current findings? Given its potential to substitute face-to-face sessions with practitioners or to be used in conjunction, this approach could enable health-promoting interventions to have substantial reach and potential cost-effectiveness. This would provide a more efficient way to manage human resources within organizations, without neglecting workers' necessities. Furthermore, social robots have the ability to engage individuals not only in a social manner but also in an emotional dimension. They can engage people of all ages in deeply personalized experiences related to their health needs and goals (Breazeal, 2011). Our results are in line with previous research that also used robots for health behavior change (e.g., Robinson et al., 2021; Sarma et al., 2014).

In the coming years, social robots will have a promising future and organizations must start expanding activities that promote positive attitudes towards artificial intelligence machines. Otherwise, negative attitudes towards robots could lead to negative attitudes towards the organization and to prejudice that could compromise the acceptance of social robots within work environments.

The results of this study are also relevant with regard to understanding the alliances that individuals can establish with robots. Robots are able to provide highly personalized and empathetic interactions with individuals, and can even lead them to accept and follow recommendations to improve their health and levels of well-being. This means that social robots may, in the future, be able to provide effective assistance in psychotherapeutic or even clinical interventions (Robinson et al., 2020). What is more, the current study provides a solid basis upon which exciting opportunities can be built in order to concentrate efforts on human-robot interaction in the service of human health.

Limitations and Directions for Future Research

It is important, however, to consider the current study's limitations when interpreting the above findings. First, in order to encourage participation, individuals' participation was voluntary, which means we may not have reached the workers who could actually benefit the most (i.e., individuals' higher health-related risk factors). This possibility of insufficient employee interest, especially among those who are high-risk employees (Schopp et al., 2014), and more likely to benefit from the intervention outcomes is a typical example of the barriers to widespread implementation of health promotion programs. Second, we did not use a proper instrument to measure whether participants had any previous experience interacting with robots. However, in the first session, the robot asked each participant whether it was the first time they were talking to a robot, and all participants responded affirmatively. This gave the research team reason to believe that it was indeed a first human-robot interaction experience for all the employees who participated in the experiment. Nonetheless, since there may be differences between interacting with robots for the first time and having had some previous interaction (Scoglio et al., 2019), upcoming investigations should analyze group differences between participants' past experience of familiarity and interaction with social robots. Third, despite the longitudinal nature of this intervention, the sample size being relatively small limits the generalizability of the findings. Future studies should focus on implementing a similar health-promoting intervention with social robots on a larger sample. This would lead to more robust conclusions regarding the changes in health-related outcomes from prolonged interaction with a social robot. Fourth, this research involved a pre-post intervention design without a control group. Future research should employ a randomized controlled trial to allow for causal inferences of intervention effects. Another limitation concerns the Wizard-of-Oz method utilized in this research. Although this method has clear strengths, enabling the robot to have a wider range of sophisticated actions in its interactions with each participant, it does have some limitations. Some of them relate to concerns that Wizard-of-Oz methods make use of social robots more as a proxy for a human and less as an independent, fully autonomous entity in itself (Riek, 2012). Future investigations should, therefore, focus on autonomous robotic agents and their interactions with workers in real work environments (Sebo et al., 2020).

Finally, this investigation was planned to take place within work environments, i.e., each session was to have been face-to-face with the robot. However, due to the COVID-19 pandemic situation and most organizations' adoption of remote work, this investigation had to take place in a non-presential context. If possible, the research team intends to develop this investigation in a presential context with another group of participants. This would permit a comparison of differences between interventions performed presentially and non-presentially, which would generate interesting data to report. Therefore, the findings presented in this paper should be treated as recommendations and directions for further research.

CONCLUSION

This investigation used a social robot as a health-promoting agent in organizations, in order to promote health behavior change. Our discoveries create new opportunities for the field of human-robot interaction, management, and organizational psychology to work together to promote health-related outcomes within workplaces. Furthermore, this work makes important contributions to the existing literature on the HAPA model and its subsequent applications, that go beyond exclusively human interaction scenarios. Although these results are preliminary, they constitute evidence that people not only respond well to robots' presence in their workplace, but that robots can also influence individuals to adopt healthier behaviors. As robots slowly make their way into people's daily lives, interacting with them in more complex settings and taking on more diverse roles, their presence can be applied to create healthier and more vigorous work environments.

Table 3.1. Study Timeline.

Initial Survey/ Baseline assessment	Week 1 Robot Session 1	Week 2 Robot Session 2	Week 3 Robot Session 3	Week 4 Robot Session 4	Week 5 Robot Session 5	Week 6 Robot Session 6	Week 7 Robot Session 7	Week 8 Robot Session 8	Final Assessment (one month after)

Table 3.2. Descriptive statistics and reliability for the study variables and HAPA constructs at two points in time.

Outcome measure	**Time 1 M *(SD)***	**Reliability α**	**Time 2 M *(SD)***	**Reliability α**
Outcome expectancies	2.91 (0.36)	0.84	3.00 (0.57)	0.89
Risk perception	1.61 (0.46)	0.90	1.70 (0.50)	0.92
Self-efficacy	2.97 (0.48)	0.75	3.28 (0.52)	0.84
Intention	4.97 (1.13)	0.80	5.63 (0.93)	0.75
Action planning	2.41 (0.94)	0.90	3.22 (0.72)	0.97
Coping planning	1.97 (0.75)	0.99	3.00 (0.76)	0.97
Perception of the robot	-	-	3.43 (0.39)	0.84
Engagement with the investigation	-	-	4.37 (0.49)	0.92

Note. *SD*= Standard Deviation.

Table 3.3 Correlations among variables studied at Time 1 and Time 2.

Variables	1	2	3	4	5	7	8	9	10	11
1. Int T1										
2. OE T1	.407*									
3. RP T1	.083	.210								
4. SE T1	.208	.463**	.069							
5. AP T1	.366*	.474**	.034	.463**						
6. CP T1	.526**	.501**	.136	.371**	.720**					
7. Int T2										
8. OE T2						.513**				
9. RP T2						.149	.021			
10. SE T2						.104	.370*	.033		
11. AP T2						.437**	.013	.077	.591**	
12. CP T2						.484**	.244	.038	.329*	.738**

Note: Int = intention; OE= outcome expectancies; RP= risk perception: SE= self-efficacy; AP= action planning; CP= coping planning. ***p* <.01, * *p*< .05

Table 3.4. Results of the mediations analysis.

Hypothesis	SE[a]	Indirect Effect	Bootstrapping IC 95%		M[b]
			Lower	Upper	
H2a: Outcome expectancies —→Intention —→Action planning	.016	.018**	.227	.253	T
H2b: Outcome expectancies —→Intention—→Coping planning	.019	.023**	.356	.385	P
H3a: Risk perception—→Intention —→Action planning	.035	.130**	.346	.380	T
H3b: Risk perception—→Intention —→Coping planning	.009	.017**	.502	.530	T
H4a: Self-efficacy—→Intention —→Action planning	.013	.054**	.059	.089	T
H4b: Self-efficacy—→Intention —→Coping planning	.014	.095**	.141	.173	T

H: X—→M—→Y **p <.001; 2,000 bootstrap samples

SE[a]= standardized errors; M[b]= Mediation (T= total, P= partial)

CHAPTER 5

THE USE OF ROBOTS IN THE WORKPLACE: CONCLUSIONS FROM A HEALTH PROMOTING INTERVENTION USING SOCIAL ROBOTS.

Abstract

Workplace wellness and health programs constitute a preventive measure to help avoid healthcare costs for companies, with additional benefits for employee productivity and other organizational outcomes. Interventions using social robots may have some advantages regarding other conventional telemedicine applications, since they can deliver personalized feedback and counseling. This investigation focused on a health-promoting intervention within work environments, by comparing the efficacy of the intervention on two distinct groups, one followed by a human agent and the other by a robot agent. Participants (n=56) were recruited from two portuguese organizations and led through eight sessions with the social agent, with the goal to encourage health behavior change and the adoption of a healthier lifestyle. Results indicate that the group followed by the robot agent revealed better post-intervention scores than the group followed by the human agent, specifically in productivity despite presenteeism and mental well-being levels. No effects were found concerning the work engagement level of participants. This study provides interestingly new findings for health behavior change literature and human-robot interaction literature, by demonstrating the potentialities of using social robots to establish therapeutic and worth relationships with employees in their workplaces.

Keywords: human-robot interaction; workplace intervention; health intervention.

INTRODUCTION

The last few years have been marked by the emergence and establishment of Industry 4.0 and with it, several technological advances that are making robotics more and more common in everyday life. This has open new possibilities and applications for social robots, including their use for health applications (Breazeal, 2011). Social robots can be useful in a variety of settings, such as hospitals, healthcare, therapy and also for promoting the adoption of health behaviors (Sarma et al., 2014). Social robots can also have some advantages regarding other telemedicine applications, since they can deliver personalized behavioral change interventions (Scoglio et al., 2019). Notwithstanding, their social attributes may provide a helpful experience within individuals, entirely personalized to their personal needs and goals. Workplace wellness and health promotion programs constitute a preventive measure to help avoid healthcare costs for companies and also to increase productivity and other organizational outcomes, as well improving employee well-being (Jones et al., 2019a). Those programs based on health behavior change are developed to assist individuals in adopting healthier lifestyles, by adjusting their health behaviors (Beinema et al., 2021). In general, workplace interventions focus on chronic health conditions and their associate multiple health risk factors (Schopp et al., 2014). Those constitute the most common and preventable health concerns, since they are directly related to lifestyle risk factors. Cardiovascular diseases, diabetes, high cholesterol, smoking, stress sedentarism are some of the examples (Schopp et al., 2014). However, most of those programs are not theory-driven and very few have personalized feedback (Webb et al., 2010). Most of these interventions are based on the Health Action Process Approach (HAPA), a theoretical framework designed to understand health behavior change (Schwarzer, 2008). Health behavior change programs have been also associated with more effective results than other strategies such as health education and training (Schopp et al., 2014). In a more extensive view, those type of programs have also been linked to improvements in workers' satisfaction, lower absenteeism, promote a sense of community, and improvements in long-term health (Merrill et al., 2011).

Workplace health promotion programs are also linked to decreased levels of presenteeism (Ammendolia et al., 2016). Presenteeism is defined as the behavior of working in the state of ill-health (Ruhle et al., 2020), often associated with hidden costs for organizations. Several approaches have been linked to presenteeism, such as the job demands-resources (JD-R) model (Bakker & Demerouti, 2007). This model states that presenteeism may arise because of a lack of resources in the workplace, causing stress to employees and forcing them to deal with extreme job demands (McGregor et al., 2016). It is suggested that intervention programs should focus on helping workers how to better manage job demands, as well as promoting workplace resources as an innovative solution to address the issue of increased presenteeism (McGregor et al., 2016). With this in mind, it is possible that robots can be used as an important workplace resource to reduce presenteeism demands, while help employees to adopt healthier behaviors.

Although health behavior change can enhance some health conditions, it is known that behavioral change can be difficult, especially in the long run (Beinema et al., 2021). Interventions using social robots may provide major benefits compared to other telemedicine applications, since they promote human-robot interaction and social robots can ask questions, give feedback, and can offer advice that is personalized to the user (Breazeal, 2011). Nevertheless, these advantages may only appear if those interactions with the social agent are incorporated in several sessions, over a longer period of time.

With this in mind, and framing into presenteeism and HAPA theoretical background, the present investigation had the purpose of developing a longitudinal health promoting intervention using a social robot and a human with the roles of health-promoting agents.

We focused on four groups of lifestyle risk problems: physical inactivity, poor dietary habits, tobacco consumption and stress management. Those are the ones more related with chronic health diseases (Schopp et al., 2014), besides being also the ones more present in workplace scenarios (Mazzola et al., 2017).

This research pretends to contribute for presenteeism literature, by displaying an intervention on workplace illness and their impact on productivity and other organizational outcomes, such as work engagement and role ambiguity. Moreover, we are also interested in contributing to HAPA theoretical framework by providing an application of this model through an artificial intelligence agent, following previous works using HAPA-driven technological health interventions (e.g., Rollo & Prapavessis, 2020; Scheerman et al., 2020). Besides, it can also contribute to JD-R model (Bakker & Demerouti, 2007), by providing an innovative solution for managers to reduce job demands associated with presenteeism. Finally, this work can as well contribute to human-robot interaction field and the socio-cognitive aspects involved in the interaction between humans and robots.

THEORETICAL BACKGROUND AND HYPOTHESIS

Social robots as health-promoting agents

The use of artificial intelligence machines such as social robots to provide guidance for health behavior change can offer higher flexibility compared to 'normal' telemedicine methods (Sarma et al., 2014). This study follows the definition of social robot given by the authors Bartneck and Forlizzi (2004, p.2): *"a social robot is an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact"*. Social robots have been used to provide therapeutic assistance in healthcare for a wide-ranging of users, from children to adults and even for the elderly (Cao et al., 2019; Vlachos & Schärfe, 2014). They can be used to motivate, coach, educate, provide feedback and social support, and improve compliance with health behavior change programs. In this way, since social robots can establish personalized and affective relationships with users, they can help them in meeting specific targets, such as mental and behavioral goals (Sarma et al., 2014) and also to improve individuals' quality of life (Costescu et al., 2014). Organizations and public health systems are facing difficulties in provide face-to-face individualized health counseling (Delponte, 2018). Using social robots may provide opportunities to improve access to health promotion programs and encourage health behavioral change (da Silva et al., 2018).

Human-robot interaction literature is rich on interventions that shows that robots can be used to improve individuals' psychological and physical health. A meta-analysis by Costescu and colleagues (Costescu et al., 2014) found out medium significant effect of robot-enhanced therapy on improving behavioral and cognitive aspects for individuals involved in psychotherapy treatments. Another meta-analysis regarding the use of social robots in mental health and wellness interventions found significant differences in patients' mood and quality of life, after intervention with the robot (Scoglio et al., 2019). Another investigation that used a social robot to provide personalized feedback for health promotion found out that patients reported to be as comfortable to discuss health-related topics with a robot than with a human (Robinson et al., 2021). Furthermore, a pilot randomized controlled trial found that people reduced the average number of high-calorie foods and drinks after completing an intervention with the robot, without any human involvement (Robinson et al., 2020).

Although these interesting findings, there are still some gaps in human-robot interaction literature. Firstly, the majority of the studies are published in robotic journals, which made them focus almost exclusively on technical details of robots, instead of focusing on the intervening variables and methodological details (Costescu et al., 2014). With the present investigation, we aim to emphasize some psychological and organizational aspects that can be relevant in the interaction between humans and robots. Moreover, we intend to compare the intervention in two groups of participants, one with a robotic agent and the other with a human agent. To our knowledge, this constitutes an unusual methodological approach, although with important advantages in understanding the key differences in the interaction between humans and robots. In line with that, the use of robots for therapy and counseling purposes have been limited to education and engagement concerning healthcare issues (da Silva et al., 2018). The dialogue and interaction between the human and the robot have not been a crucial focus, although recent investigations already demonstrated that individuals report feeling comfortable discussing health issues with robots rather than with a human counselor, since robots are perceived as nonjudgmental (da Silva et al., 2018). This study centers on the dialogue and interaction between the participants and the robot agent, in order to effectively understand the effect it may have on health behavior change.

Notwithstanding, social robots might possess characteristics that may lead individuals to perform better in health-promoting interventions, compared to human counselors.

The human-robot interaction field has been guided by debates concerning the capability of humans to establish empathic and trustworthy relationships with social robots (Malinowska, 2021). Those processes have been analyzed extensively in human-robot interaction research through socio-cognitive explanations, and a great amount of research have found that people do sympathize and even trust in robots (Kok & Soh, 2020; Leite et al., 2011). Moreover, social robots can as well engage in actions to reduce individuals' stress, in the form of social supportive behaviors (Leite et al., 2011). This means that although robots don’t hold a real consciousness, they can demonstrate emphatic and trustworthy behaviors (Malinowska, 2021). This happens because humans apply the same socio-cognitive processes when interacting with social robots than when interacting with other humans (Breazeal, 2000; Dang & Liu, 2021). Therewith, interaction with social robots can be easy if social robots display rich social behavior and social feature levels similar to humans (Krämer et al., 2012). All this evidence may suggest that people feel more comfortable discussing health-related issues with robots than with human agents, since robots are considered to be as more tolerant, nonjudgmental, and capable of demonstrating emphatic behaviors (Breazeal, 2011).

However, little is known about the social robots’ potential in improving individuals’ health and well-being in working populations. Work environments are places where individuals spend the majority of their time, being therefore great for the application of human-robot interventions. Following recent recommendations concerning the use of robots in workplaces (e.g., Sebo et al., 2020), this investigation will try to fill this gap, by focusing on the potential to use a social robot as a health-promoting agent within work environments. Ultimately, although the majority of the health behavior change interventions track health outcomes throughout multiple sessions or overtime, this is not the case with robotic interventions. Those are usually developed in single-one contexts (e.g., Robinson et al., 2021), which may lead to a poor view regarding the use of robots as health-promoting agents. With the present intervention, we aimed to develop a longitudinal intervention, with multiple sessions and multiple interactions with the health promoting agent.

The HAPA model and healthy behaviors in the workplace

The HAPA model, developed by Schwarzer (1992, 2008) suggests that the adoption, initiation, and maintenance of health behaviors results from a set of social-cognitive predictors, that operate by translating intentions into behaviors (Ernsting et al., 2013). The distinguished aspect of this research is applying the HAPA model in an intervention delivered by a social robot, with the purpose of promote healthier behaviors among employees. Although several investigations have applied HAPA to health behavior change interventions, to the best of our knowledge none of HAPA interventions have compared the efficacy of the intervention with a human agent versus a robot agent, even more in a set of individual and organizational variables.

People usually engage in lifestyle risk behaviors that can compromise their physical and psychological health (Schopp et al., 2014). Beyond the directly consequences for the individual, those behaviors impose a substantial burden on society's health care resources (da Silva et al., 2018), and in turn, on organizations and companies. Workplace health programs are interventions designed to reduce health care costs, focused on the discourage of unhealth behaviors, such as physical inactivity, tobacco consumption, poor dietary habits, and stress & anxiety (Jones et al., 2019b). Those healthy risk behaviors are highly related to the most common chronic diseases at workplace, such as cardiovascular diseases, cancer, diabetes, cholesterol, and obesity, which are also the most preventable of all health concerns (Schopp et al., 2014). Health interventions in work environments are needed to support individuals in making health change behaviors into a reality, however companies usually encounter with some challenges in widespread the implementation of those programs. One of them is the insufficient employee interest, specially from worker with high-risk factors, that would benefit the most from participating (Schopp et al., 2014).

Workplace health programs can embrace different types of interventions, from biometric screening to provide clinical measures of health to wellness activities to promote healthy lifestyles, by encouraging health behavior change (such as physical activity, healthy nutrition habits, smoking cessation and stress management) (Jones et al., 2019). The majority of the participants in health style programs mentioned the lack of motivational support to engage in lifestyle changes (da Silva et al., 2018). However, some of the barriers may come from the work environments themselves. A previous investigation showed that workloads, temptations around the office and time constrains were reported as being the workplace barriers that were most associated with lack of engagement in adopting healthy lifestyles (Mazzola et al., 2017). For that reason, it is particularly vital to understand how factors in the workplace can influence worker's health behaviors, and also investigate their relationship with some key organizational variables (Mazzola et al., 2017). Below we explore some relationships between health behaviors and some organizational and individual outcomes.

The relationship between health, productivity, engagement and mental well-being

The literature has described abundant evidence suggesting that individuals' health and well-being are related to some productivity outcomes, namely presenteeism and absenteeism (Cancelliere et al., 2011; Jones et al., 2019b; LeCheminant et al., 2015). Investing in workers' health, throughout preventive health interventions (with the purpose of discouraged unhealthy behaviors), may improve employees' on-the-job performance and productivity. Since poor employee health is directly related with lower productivity (Lerner & Henke, 2008), wellness programs targeting physical activity and nutrition have been applied in organizations, with satisfactory results concerning productivity outcomes (Chen et al., 2015). There is plenty previous work showing that health-related problems are associated with higher absenteeism and presenteeism (e.g., Chen et al., 2015; Goetzel et al., 2004; Schultz & Edington, 2007). This means that workplace health programs can result in productivity gains for companies, besides the evident benefits for the individuals. Social robots can be used in workplace health programs, with the additional advantage that they may be capable to reduce the demands associated with presenteeism.

There is evidence in the human-robot interaction field that individuals' productivity can improve when a robotic agent is present, as opposed to situations with no robot presence (Kuchenbrandt et al., 2013; Tsarouchi et al., 2017). As stated earlier, previous work has established that people can enroll in empathic and trustworthy relationships with robots, because they are perceived as supportive, reliable, and tolerant (Breazeal, 2011). Those aspects may help to better intervention scores for the individuals followed by the robot agent. Specifically, that may result in better health-related outcomes, and consequently, higher productivity. We formulate then the following hypothesis:

H1: The intervention with the robot agent will be associated with an improvement in individuals' productivity despite sickness presenteeism at Time 2. Specifically, those participants will have post-test scores for productivity despite presenteeism significantly higher than the scores of the group with the human agent.

Employee engagement has been an organizational variable conceptualized in several ways, all of which incorporate behavioral, cognitive and affective dimensions (Lee et al., 2017). For this paper we focused on workers' emotional and behavioral reactions, analyzing physical engagement and emotional engagement. Physical engagement concerns the investment of effort, physical energy, and hard work with regard to task completion, whereas emotional engagement concerns emotional and affective reactions related to the work role itself (Luksyte et al., 2015; Mañas et al., 2018).

Some previous research (Chen et al., 2015) raised awareness on the relationship between health conditions and its correlations with employee engagement. Preceding investigations have clearly shown that work engagement is associated with a wide range of work and health outcomes, and in turn associated with increased workers' quality of life and positive work-related behaviors (Garg & Singh, 2020). Engagement has been conceptualized as an organizational variable with specific behavioral, cognitive and affective dimensions that help individuals commit to their work (Othman et al., 2017).

Overall, slightly efforts have been made to integrate work engagement on human-robot interaction literature. To date, human-robot interaction literature has in general, shown evidence that individuals can become emotionally attached to robots, which may lead them to become more engaged in their tasks (You & Robert, 2018). Since greater health is related with better engagement levels (Garg & Singh, 2020), we may consider that the health-intervention with the robot agent would improve individuals' engagement levels at post-interventions scores. We rely again on the assumption that the interaction with the robot agent will lead to better post-interventions scores than the intervention with the human agent, since social robots possess affective attributes to sustain people's engagement, motivation, and provide social support (Breazeal, 2011). Besides, the robot agent may also be a valuable resource for reducing the demands associated with presentism, such as is the case of work engagement (McGregor et al., 2016). For this reason we postulate:

H2: The intervention with the robot agent will be associated with an improvement in individuals' engagement at Time 2. Specifically, those participants will have post-test scores for engagement significantly higher than the scores of the group with the human agent.

There is a growing interest in the concept of mental well-being and its implications to overall aspects of human life, including work-life aspects (Tennant et al., 2007). While it may be evident that physical activity, good dietary habits and no tobacco consumption can directly improve well-being and quality of life (Fox, 1999), it may not be that clear when focusing on its associations with mental well-being aspects. Mental well-being is described as complex construct focused on the subjective experience of life satisfaction, happiness, self-realization, and psychological functioning. aspects (Tennant et al., 2007). It has been emerged as an important predictor of general health and longevity, being linked to some behavioral risk factors such as tobacco consumption, obesity, lack of physical activity and poor dietary habits (Stranges et al., 2014). In general, the lack of mental well-being has been associated with physical diseases and unhealthy lifestyles, which makes mental well-being an important public health concern (Stranges et al., 2014).

Nevertheless, a notable number of human-robot interactions studies have revealed that social robots can assist people to easily improve their psychological outcomes (Costescu et al., 2014; Scoglio et al., 2019). Social robots can provide comfort, listen without interrupt, and give support (da Silva et al., 2018). They are also seen as to be free from the "social baggage" that is associated with the human counsellors and therapists, making them appeared as nonjudgmental in a way that nurtures willingness to disclose (Breazeal, 2011). Moreover, social robots can be used as a job resource (in the form of social support) that can assist individuals in some aspects of the psychosocial work environment that may have an impact on their mental health. For these reasons, we consider that the participants guided by the social robot will have better well-being levels at post-interventions scores than the group guided by the human agent. We hypothesized:

H3: The intervention with the robot agent will be associated with an improvement in individuals' mental well-being level at Time 2. Specifically, those participants will have post-test scores for mental well-being significantly higher than the scores of the group with the human agent.

Overall, one of the main purposes of the present investigation is to compare the health behavior intervention between two groups: one guided by a robotic agent and the other guided by a human agent. As one can note analyzing our hypothesis *1* to *3*, we are interested in investigating hypothesis about the effect of the type of agent on each of the outcome variables. More specifically, we wish to determine that the effect of the robotic agent is associated with better results in the outcome measures (productivity despite sickness presenteeism, engagement and mental well-being), or whether it may be related to some outcomes but not others. For the last hypothesis, we intend to test if the type of agent (robot or human) can influence post-interventions scores in all outcome measures:

H4: The type of agent will influence the levels of productivity despite sickness presenteeism, engagement and mental well-being in the post-intervention scores.

METHOD

Participants

Sixty-eight participants were recruited from two portuguese organizations, from services and retail providers, through an invitation to participate in a health promotion program. Prior to the beginning of the study, written consent was obtained from participants by the research team. Ethical approval was gained from the two universities ethics' committee involved in the investigation. Ten participants dropped out throughout the sessions and two didn't complete the final assessment at Time 2, resulting in a final dataset of fifty-six valid participants. The participants received no reward or any compensation.

Age ranged between 22 to 53 years old (*M*= 37.66; *SD*= 8.67). 74,5% of the sample were female and 25,5% were male. The majority of the participants were married (40%) or living in a nonmarital partnership (29,1%). In terms of academic qualifications, the sample is highly qualified – 56,4% reported to have at least a completed undergraduate degree. 92,6% also reported to have a permanent contract with the company. Several independent sample *t* tests were performed in order to assure that there were no significant differences between the two groups concerning the age ($t_{(48)}$ = .677, *p*=.252), gender ($t_{(53)}$ = -.926, *p*=.179) and academic qualifications ($t_{(53)}$ = -.450, *p*=.327).

Materials - EMYS robot (for the robot agent condition)

The robot used in this research is EMYS, a social robot with a system designed to simulate certain features of the human mind (figure 5.1.). EMYS has a head and no body, it can move its head, speak, and use certain facial expressions to connect with the user. The robot is specially designed for human-robot interaction experiments. However, it needs to be assisted by a human, in a "Wizard of Oz" paradigm. This method involves simulating autonomy with a human "assistant", manipulating the robot's behavioral features, such as its speech. This paradigm is commonly applied in interventions on human-robot interaction field (e.g., Dziergwa et al., 2018; Paradeda et al., 2019). Although the participants felt the robot was completely autonomous, in reality it was controlled by a researcher. The aim was that the participants would not realize this. The university's ethics commission (code 69/2019) approved the use of human-robot interaction in this experiment.

Figure 5.1. The EMYS robot used in the present investigation

Intervention design and content

The intervention lasted 3 months, from the fulfillment of the baseline assessment to the fulfillment of the post-intervention questionnaire. During the baseline assessment, each participant had the possibility to choose a health-related behavior which they would like to focus their participation. There were four possibilities: physical activity, nutrition habits, tobacco consumption and stress & anxiety. Afterwards, they were randomly distributed between the two conditions (robot agent condition or human agent condition). On the first session with the agent (human or robot), participants had the chance to confirm or modify the health-related focus of their participation. Participants' distribution over the four conditions was as it follows: physical activity (*n* =25); nutrition habits (*n* =16); tobacco consumption (*n* = 4) and stress & anxiety (*n* =11).

In total, each participant had eight sessions with the agent, throughout eight weeks (one session of 20-30 minutes per week). Due to the impact of the COVID-19 pandemic, all the sessions occurred in a videoconference format, via Microsoft platform Teams. All the sessions were recorded, with the participants consent. In the final assessment, when responding to a question regarding videoconference format of the investigation, 78,6% of the participants responded that the research format didn't compromise their commitment and performance with the investigation. A *t* test was performed in order to assure that there were no differences between the participants who answered that the research format didn't compromise their commitment and those who answered that it might have compromised ($t_{(54)} = .048$, $p = .481$). The intervention targeted multiple behaviors change techniques that mapped on to the constructs in the motivational and volitional phases of the HAPA framework (Schwarzer, 2008). This socio-cognitive model with the aim to describe, explain and modify health behaviors within individuals has been applied in several interventions, with good results in promoting health behavior change (Prem et al., 2021; Rollo & Prapavessis, 2020). In this intervention, participants were guided by the agents to set goals, monitor their behavior, elaborate action plans and coping plans and increase their self-efficacy by watching videos and testimonials. Specifically, throughout the eight sessions, the robot agent targeted the following constructs: outcome expectancies (e.g., the robot encouraged the individuals to formulate their own potential pros and cons of the health behavior change); self-efficacy (e.g., instructions were given and role modelling of effective behaviors); risk perceptions (e.g., the robot gave information about the existence of health risks); social influences (e.g., the robot asked individuals to demonstrate support for their co-workers who were also engaged in the intervention); action planning (e.g., individuals were asked to make concrete plans of when and how they should perform the health behavior, using the if-then formulation); coping planning (e.g., individuals were asked to identify barriers and possible solutions by making coping plans); and action control (e.g., the agent provides a digital calendar for individuals to monitor and point out (daily or weekly) the times they practice the health behaviors). Besides that, in the beginning of each session the agent discussed with the participants what they've done since the last session to follow on their plans, and then provided appropriate feedback.

Measures

All assessments listed below were self-report measures that were completed online in response to emails that included links to the surveys. This approach allowed participants to complete these assessments in their own time to reduce research burden, and allowed the assessments to both be independent of the research team and separate from the intervention with the robot agent. All measures were assessed prior to the intervention (Time 1) and one month before the intervention (Time 2). At both times, all measures presented satisfactory internal consistency.

Productivity despite presenteeism

Productivity despite presenteeism was measured using an adaptation of the Stanford Presenteeism Scale's (SPS-6), original version developed by Koopman and colleagues (2002). The SPS-6 measures individuals' capacity to complete work and to avoid distraction. Examples of the items include "I would feel desperate with regard to accomplishing certain tasks" and "My job would be much harder to handle". The Likert scale ranges from 1- strongly disagree to 5- strongly agree. Cronbach's α was .81 on Time 1 and .87 for Time 2.

Work engagement

Engagement was measured on a 12-item scale (Rich et al., 2010) designed to measure two global dimensions of the engagement construct, namely emotional engagement and physical engagement. Emotional engagement assesses the extent to which people experienced positive feelings about their work in the assigned task (e.g., “I am proud of my work”) and physical engagement assesses to what extent they invested physical energy and effort in their task (e.g., “I have devoted a lot of energy to my work.”). This scale ranges from 1- never to 5- always. Cronbach’s α was .93 on Time 1 and .92 for Time 2.

Mental well-being

Mental well-being was measured through the Warwick Edinburgh Mental Well-being Scale (Tennant et al., 2007) comprising 14 items that evaluate mental well-being in the general population, cover both feeling and functioning aspects of mental well-being. Examples of the items include “I’ve been dealing with problems well” and “I’ve been feeling optimistic about the future”. The scale ranges from 1 (never) to 5 (always), where higher levels are associated with better mental well-being. Cronbach’s α was .91 on Time 1 and .92 for Time 2.

RESULTS

All analyses were performed using SPSS version 26. Descriptive statistics and correlations among variables can be found on Table 4.4. No significant differences were found concerning the covariate (type of condition), which means that the type of condition did not influence the effect of the type of agent on the outcome variables.

Concerning the first hypothesis, which predicted that the use of the robot agent would improve participants' productivity despite sickness presenteeism at Time 2, we can observe that for the robot agent group, the post-test mean levels of productivity were significantly higher than at pre-test (M_{T1}= 3.19, M_{T2}=3.73, $t_{(1,46)}$ =9.041, p<.001, d=.89). For the human agent group, levels of productivity despite sickness presenteeism at Time 2 were not statistically different from those at Time 1 (M_{T1}= 3.12, M_{T2}=2.82, $t_{(1,41)}$ =.05 p=.62, d= .59). We tested our first hypothesis by comparing the change in productivity despite sickness presenteeism of the robot agent group with the change that occurred in the productivity despite sickness presenteeism of the human agent group at the same assessment moments, which was from the pre-intervention measurement at T1 to the T2 measurement (post-intervention measurement). In a paired *t* test, the difference in change in productivity despite sickness presenteeism for the two groups was significant ($t_{(47)}$ = -25.953, p<.001). These results support our first hypothesis by showing that the intervention with the robot agent was effective in increasing participants' productivity.

Regarding the second hypothesis, it predicted that the use of the robot agent would be associated with a positive change in participants' engagement level at Time 2. Thus, our expectation was that the scores of the participants' engagement would change significantly from Time 1 to Time 2. A *t* test showed that there were no differences among the level of engagement between Time 1 and Time 2 for both robot agent condition (M_{T1}= 4.21, M_{T2}=4.12, $t_{(33)}$ 1.161, p>.05) and for human agent condition (M_{T1}= 3.87, M_{T2}=4.05, $t_{(18)}$ -1.722, p >.05). A further analysis was carried out of these results using a repeated measures ANOVA, to test if there were significant differences between the type of agent and the participants' engagement level at Time 1 and Time 2. The results showed that there were no significant differences ($F_{(1, 49)}$ = .5176, p > .005). Overall, these results do not corroborate hypothesis 2.

Our third hypothesis predicted that the intervention with the robot agent would be associated with a positive change in participants' mental well-being level at Time 2. Thus, our expectation was that the scores of the participants' mental well-being would change significantly from Time 1 to Time 2. Moreover, we expected that this change would be greater for the robot agent condition than the one observed for the human agent condition. The post-mean levels determined that the mean scores for mental well-being differed significantly across the two assessment moments for the robot agent condition (M_{T1}= 3.57, M_{T2}=3.99, $t_{(37)}$ =-4.130, p<.001, d=.61). For the human agent condition, the mean scores were not statistically significant (M_{T1}= 3.46, M_{T2}=3.50, $t_{(18)}$ =.408, p>.005, d=.56). In a paired *t* test, the difference in change in mental well-being for the two groups was significant ($t_{(54)}$ = -3.412, p<.001). This means that, participants in the robot agent condition showed higher levels of well-being at Time 2 than the participants in the human agent condition. A repeated-measures ANOVA was performed, to understand the relationship between the type of agent and individuals' well-being, at Time 1 *vs* Time 2. The results revealed a main effect of the type of agent on the well-being levels ($F_{(1, 53)}$ = 4.517, $p < .005$; $\eta^2 = .079$). These results support our third hypothesis by showing that the intervention with the robot agent was effective in increasing participants' well-being levels.

Regarding our fourth hypothesis, which predicted that the type of agent would influence the levels of productivity despite sickness presenteeism, mental well-being and engagement in the post-intervention scores, a One-Way MANOVA was performed, with the type of condition included as a covariate. There was a statistically significant difference in the outcome variables based on the type of agent ($F_{(1, 43)}$ = 8.997, p < .001, Wilk's Λ = 0.597, partial $\eta 2$ = .40). In particular, the type of agent has a statistically significant effect on productivity despite presenteeism post-intervention scores ($F_{(1, 45)}$ =

17.628, p < .001; partial η2 = .29) (figure 5.2.) and on mental well-being post-intervention scores ($F_{(1, 45)}$ = 11.009, p = .002; partial η2 = .20) (figure 5.3.). No statistically significant differences were found between the type of agent and engagement post-intervention scores ($F_{(1, 45)}$ = .872, p = .352; partial η2 = .02).

Table 4.4. Descriptive statistics and correlations among studied variables.

				Correlations				
Variables	***N***	***M***	***SD***	**1**	**2**	**3**	**4**	**5**
1. Productivity despite presenteeism T1	43	3.17	0.45					
2. Work Engagement T1	54	4.07	0.56	.064				
3. Mental well-being T1	55	3.53	0.55	-.069	.506**			
4. Productivity despite presenteeism T2	48	3.40	0.85	-.151	.403**	.308*		
5. Work Engagement T2	52	4.08	0.52	.010	.678**	.276*	.380*	
6. Mental well-being T2	55	3.83	0.54	.196	.277*	.323*	.268	.170

Note. *SD*= Standard Deviation. ** p < .01; * p < .05.

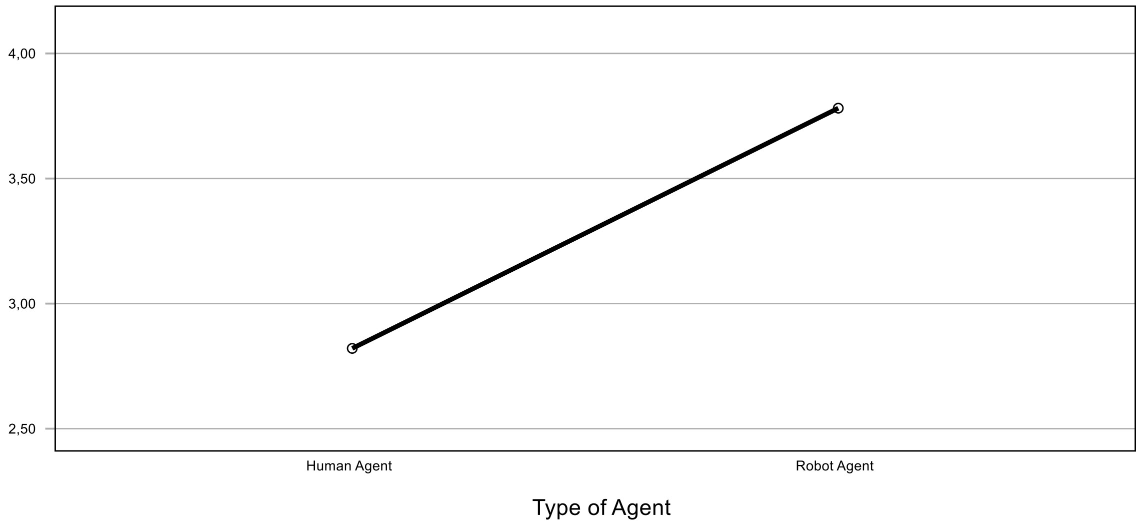

Figure 5.2. Effect of the type of agent on productivity despite presenteeism level.

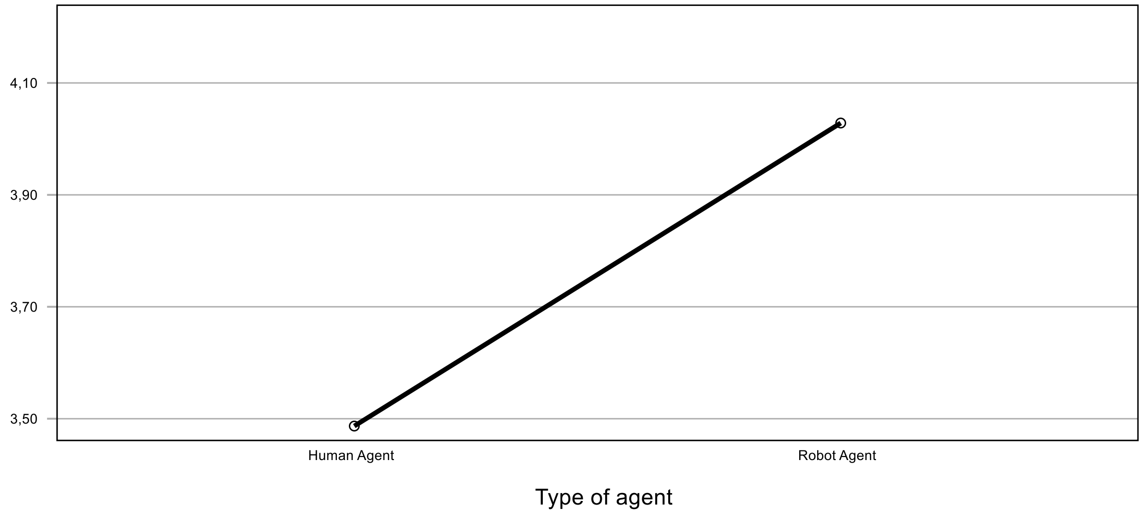

Figure 5.3. Effect of the type of agent on mental well-being level.

DISCUSSION

This longitudinal investigation has compared the role of a robot agent and a human agent as a health-promoting agents within work contexts. The main focus of the study was to analyze which type of agent would be associated with better results in a set of individual and organizational outcomes. Our results showed that the intervention with the robot agent was associated with improvements in individuals' productivity despite sickness presenteeism and well-being levels. However, no effects were found regarding the engagement levels of the participants on post-intervention scores.
This constitutes interestingly new findings for health behavior change literature (Scheerman et al., 2020; Webb et al., 2010), HAPA theoretical framework (Schwarzer, 2008), JD-R approach to presenteeism (Bakker & Demerouti, 2007; McGregor et al., 2016), and human-robot interaction literature (Robinson et al., 2021), by demonstrating the potentialities of using social robots to establish therapeutic and worth relationships with employees in their workplaces, while improving their health status. Furthermore, our results may also contribute for presenteeism literature, by demonstrating the potentialities of a health promotion program using social robots to enhance productivity despite

presenteeism. This may lead to an improvement in workers' productivity and well-being levels, and consequently an increase in related health and quality of life. Below we explore in more detail the theoretical and practical implications of this research.

Theoretical and practical implications

The results of our research extend previous findings from health behavior change literature and HAPA framework, and its applications in the context of technology-driven interventions (Beinema et al., 2021; Costescu et al., 2014; da Silva et al., 2018; Robinson et al., 2021). Furthermore, the use of social robots provides potential advantages over other technology-delivered applications in workplace contexts, suggesting that robots can encourage health behavior change in individuals and additionally, they can engage in therapeutical relationships with individuals (da Silva et al., 2018). This can be especially relevant for scenarios such as medical and therapy settings, by demonstrating that even without the absence of human interaction, the use of robots may not compromise individuals' health-related outcomes. Moreover, this investigation also contributes to JD-R model, by showing that social robots can be used in workplace interventions in order to reduce job demands associated with presenteeism (McGregor et al., 2016), by helping workers to adopt healthier behaviors.

The health-promoting intervention with the robot was not associated with improvements in engagement levels. Although we did not expect these results, it's in line with some previous research in healthcare settings, where is usual to find better results when robot is used as a complement/mediator on the relationship between the therapist and the patient, to mediate the activities of the therapist (Costescu et al., 2014). Similarly, other recent studies enhanced that robots can be a viable way to raise awareness for health education and health behaviour change, but their full integration into the clinical process may not be required (Robinson et al., 2021). Even though this can be a modest possible explanation, engagement has not been as thoroughly studied in human-robot interaction research (Sidner et al., 2004), especially in workplace scenarios. To the best of our knowledge this investigation constitutes one of the first attempts to link social robots to some organizational outcomes such as work engagement, so additional research of human-robot interaction within work environments is needed, as mentioned by previous authors (Sebo et al., 2020b; Sidner et al., 2004). This will allow interesting new findings regarding the advantages of using social robots within workplaces.

Our findings that the intervention with the robot allowed improvements in participants' productivity despite presenteeism and mental well-being are in line with a previous body of research that links human-robot interaction interventions with better productivity outcomes and individuals' psychological well-being (Costescu et al., 2014; Scoglio et al., 2019; You & Robert, 2018). This constitutes valuable information for presenteeism literature, that can harness the power of robotic agents to deliver health interventions to promote employee productivity and well-being.

Based on our current findings, we can recommend practitioners and managers to embrace the use of social robots in work environments. In line with the literature (Sebo et al., 2020b; You & Robert, 2018), there are clearly plenty of opportunities to test the implementation of social robots within workplaces. Even if not completely independent and working autonomously, social robots can complement interventions with practitioners (Robinson et al., 2021), contributing to the productivity and vitality of the workforce. Even from a manager or a therapeutic's point of view, social robots may help to reduce workload for humans, while assisting individuals reaching their goals and improve their health and quality of life (Costescu et al., 2014). They can engage people of all ages in deeply personalized experiences with their health needs and goals (Breazeal, 2011), leading them to accept and follow recommendations to improve their health and well-being levels. Furthermore, introduce social robots as health promoting agents within workplaces may help managers to deal with presenteeism and absenteeism phenomenon, related with severe costs for companies (Schultz & Edington, 2007).

Engaging in health-promoting programs constitutes a competitive advantage for organizations, especially in a current labour world facing the consequences of the COVID-19 pandemic. Companies can harness the advantages of social robots to help to create a healthy, productive, and resilient workforce, and this study provides a solid basis for such interventions.

Limitations and directions for future research

We acknowledge some limitations of the study. Firstly, the participation on this research was voluntary, which means that perhaps we didn't reach the workers who could actually benefit the most (i.e., individuals with higher health-related risk factors). Unhealthy employees may gain the most from participating in this type of health promotion programs, however they are less likely to engage in these interventions (Schopp et al., 2014). This is particularly relevant for individuals who smoke (Jones et al., 2019), and in our sample we can confirm the lack of adherence from this group. In the same line, the voluntary nature of this research makes this sample not representative of all employees who may or may not be interested in health behavior change. Upcoming research should focus on performing a similar health-promoting intervention in a larger sample, especially with artificially intelligence machines. This should lead to firm conclusions about changes in health outcomes resulting from long-term interactions with a social robot.

A further weakness concerns the Wizard-of-Oz method applied in this research. There are concerns in using Wizard-of-Oz methods, namely social deception and making the robot more as a human proxy without full autonomy than an autonomous machine (Riek, 2012). However, previous studies suggested the clear strengths of this method: allows the robot to take more complex actions in its interactions and dialogues with people; individuals can imagine what future interactions with robots will be and allows researchers to test design and communication features (Riek, 2012). Nevertheless, future research needs to focus on the interaction between autonomous robot agents and individuals (Sebo et al., 2020) in contexts of health intervention programs.

Lastly, due to COVID-19 pandemic situation and the adoption of remote work from the majority of the organizations, this intervention had to be realized in a non-presential context, where each participant had the sessions with the social agent in a videoconference format, instead of face-to-face interaction. We can relate this with the small sample size of our research, which limits the generalizability of the findings. We believe that if workers could interact face-to-face with the robot, they would be more interested in our research. Thus, if possible, the research intends to conduct this investigation in a presential context with another set of participants, in order to allow to compare differences between interventions performed presential and non-presential. We hope this will produce interesting data to report.

CONCLUSION

This investigation compared the impact of a health behavior change intervention between two types of social agents (a human agent and a robot agent) in a set of organizational and individual outcomes. The results shows that the robot agent was associated with better post-interventions scores in individuals' productivity despite sickness presenteeism and mental well-being. Although these constitutes preliminary results, robots can be used for delivering virtual support for health behavioral change. At a critical junction where the pandemic crisis caused by COVID-19 virus is forcing long-distance relationships like remote work and teleconsulting, a great opportunity can rely on robotic partners, to enhance social interactions while improving people's health outcomes.

CHAPTER 6

CONCLUSION

INTRODUCTION

Presenteeism has been pointed out by researchers and practitioners as a steadily increasing field (Ruhle et al., 2020). Due to the impact of COVID-19 pandemic on organizations and their workers, there seems to be no question that strain on workers will continue to increase in the upcoming times. More than ever, companies should join forces in order to provide healthy work environments for their employees. Additionally, the increasingly popularity of teleworking and remote work makes more difficult for supervisors to intervene in the interest of employees health, which could possibly lead to an increase in presenteeism phenomena (Lohaus & Habermann, 2019).

Although progress has been made in presenteeism research, a number of topics remain unanswered. To begin with, presenteeism research has been guided by an almost exclusively focus on individual. Since the consequences of presenteeism are not only restricted to those who are present (Lohaus & Habermann, 2019b), it is crucial to analyze the influence of presenteeism behaviors on others, which have not been integrated into presenteeism research. Next, the individual focus of presenteeism and leadership research has neglected the influence of some social cognitive aspects in this relationship. The majority of prior research has only approached presenteeism and leadership from an individual agency perspective. Furthermore, despite the relevance of human-robot interaction within these days, a small number of management studies have addressed the possibility of incorporating artificial intelligence machines in the workplaces, in the form of human-robot teams and robotic leadership (Canbek, 2019). Lastly, it is also unknown how the potentialities of social robots can be leveraged to stimulate the creation of more healthier and vigorous work environments, and thus, to reduce presenteeism within organizations.

These gaps guided this thesis. The main goal was to contribute for presenteeism theoretical framework, by integrate the unexplored connections between presenteeism and leadership, human-robot interaction, and health behavior change. In order to accomplish the main goal, three subgoals were defined. First, this thesis aimed to contribute for the development and establishment of a new concept, that is leadership presenteeism. Second, this thesis aimed to analyze how robots could be effective leaders, by adapting human leadership theories to the field of human-robot interaction. Finally, this thesis aimed to analyze the role of social robots as health-promoting agents in organizations, for health behavior change promotion and decreasing of presenteeism levels.

In this final chapter, we discuss the theoretical and practical implications of this thesis. Then, we present limitations of this thesis and directions for future research. We finish this thesis with a brief conclusion about the main contribution of this work.

THEORETICAL IMPLICATIONS

This thesis makes important contributions to the existing literature on presenteeism and its relationships with leadership theories, social cognition, social robotics field and health behavior change theories (Bandura, 2004; Lohaus & Habermann, 2019b; Savela et al., 2021; Schwarzer, 1992, 2008). By doing this, we respond to calls from previous authors that stated the importance of including the perspectives of various disciplines to understand the presenteeism phenomenon (Ruhle et al., 2020). Below we detail the contribution of this work for each discipline.

With this thesis we contribute for presenteeism framework model by showing the impact that leaders' presenteeism can have on employees' behavioral reactions. Our work establishes in the literature the concept of leadership presenteeism, by showing that leaders' social influence may thus play an important role in shaping employees' behaviors and productivity. Following Dietz and colleagues (2020) findings, this thesis also states leaders as role models with the capacity of spreading presenteeism into their teams, damaging employee productivity and engagement. Furthermore, we deflect from the individual approach that is been guiding presenteeism research (Luksyte et al., 2015), investigated presenteeism from a new perspective, by assessing the impact of leaders' presenteeism on individuals and teams. To the best of our knowledge, this is one of the first investigations to manipulate leaders' health conditions in an experimental setting. As far as we know, it is also the first study to analyze how teams work in a presenteeism context.

This thesis provides distinguished contributions for SCT framework (Wood & Bandura, 1989), by advancing the existing knowledge about SCT and the core properties of human agency, contributing to new theoretical developments that integrate social-cognitive aspects in the field of presenteeism research. In addition, this investigation is also one of the first to use proxy agents, as SCT suggests, to explain the mechanisms underlying the influence that a leader's health status can have on their followers and teams. Most of prior research has only approached presenteeism from an individual agency perspective, and with this thesis we establish leaders as proxy agents that can influence the surrounding collective agency Similarly to Cooper and colleagues (2016), we extended the aspects of the general SCT that were most relevant to explain presenteeism behaviors from a leaders' perspective. we concentrated on leaders' own health status, which is a revolutionary way to look at the role of leaders in work environments. Leaders are responsible for creating and maintaining a psychologically healthy work environment (Gilbreath & Karimi, 2012), but they cannot do this if the importance of their own health condition is underrated. Since presenteeism can have numerous causes, it is crucial to highlight the important role leaders' own health status plays in contributing to their teams' collective effectiveness and productivity.

Moreover, this thesis also frames SCT into human-robot interaction literature, by showing that robots can perform the role of leaders, as social agents that guides the interactions and behaviors of the team through a shared task, to achieve a common goal. Although some effort has been made to apply SCT to the artificial intelligence field (Henschel et al., 2020), this thesis provides valuable evidence that when individuals interact with entities they lack specific knowledge of (such as social robots), they commonly apply human socio-cognitive processes to predict their behaviors and to explain the other entity's behavior (Marchesi et al., 2019). As a result, individuals can recognize and accept supervisory and authoritative behaviors from a social robot, in the same way they do for humans. SCT can be a useful way to explain individuals' perceptions of robot behaviors. By applying social cognition processes to robot leadership, we can assume that perhaps we can recognize robots' leadership behaviors because they behave like leaders, even though we know that they are non-conscious entities.

Finally, the research reported in this thesis advances knowledge about the application of the HAPA theoretical framework, that goes beyond exclusively human interaction scenarios and can be applied in the context of technology-driven interventions. First, our results indicate that when properly implemented, artificial intelligence machines can be used within organizations as social agents capable of improve individuals' health and well-being. With this thesis we expect to set the agenda for future research to address the application of the HAPA model to human-robot interaction scenarios. Notwithstanding, social robots can be applied to reduce presenteeism among employees, by providing counseling and support for behavioral interventions. We expect that further research may focus on interventions that links health behavior change and presenteeism reduction, with the help of social robots. Moreover, we respond to recent calls from authors to test intentions as an important variable on HAPA model relations and effects (Schwarzer & Hamilton, n.d.; C. Q. Zhang et al., 2019a). Our work states intentions as a mediator to overcome the motivation-behavior gap. This indicates that intentions are an intervening variable in HAPA model, between the constructs of the motivational phase and the constructs of the volitional phase.

PRACTICAL IMPLICATIONS

What practical recommendations can we get from our findings? The research reported in this thesis offers practical implications for managers, supervisors, academics, and anyone interested in building healthier work environments for employees. In particular, the findings of this thesis are meaningful to human resources managers, specifically to their human resources management and development practices.

First, managing presenteeism effectively can result in competitive advantages for organizations (Hemp, 2004; Johns, 2010). Supervisors have to understand that they have an active role in influencing workers' productivity and help build work environments that maximize individual employees' potential and productivity. Work-related interventions can be beneficial if they specifically target each health problem and incorporate explicit work-related outcomes (Joyce et al., 2016). Organizations need to develop the tools to monitor and diagnose a presenteeism climate in order to then implement measures to reduce its negative impacts on workers' performance and productivity (Ferreira et al., 2019).

Focusing on the relationship between presenteeism and health conditions, the research reported in this thesis is particularly relevant for psychological, physical, and contagious diseases and how managers must lead with them in the workplaces. For instance, appropriate infection-control measures should be implemented, especially in a world still dealing with COVID-19 pandemic. Such measures should be minimizing the chances of exposure (thorough remote work), ensuring greater cleaning care, providing employees with training sessions and seasonal vaccinations. Particular attention should be given to leaders infected with contagious diseases such as influenza, since the present findings suggest a negative impact on individuals' productivity when leaders come to work with influenza. Measures can be taken so as not foster presenteeism cultures within organizations, and to introduce measures that promote full recovery from contagious illnesses before going back to work.

Our results highlight the importance of motivating organizations to implement changes regarding the acceptance of mental illnesses, and to reduce the negative attitudes that surround these illnesses. Managers must develop policies or create workplace programs and interventions to help reduce the stigmatization of mental illnesses in the workplace (Bhui et al., 2012). In addition, organizations can develop initiatives that not only focus on preventing common mental illnesses at work, but also facilitate the recovery of workers diagnosed with psychological disorders (Joyce et al., 2016). However, in order to be effective, these interventions must incorporate all organizational interveners, such as sick workers, managers, and coworkers. Managers should also encourage a work environment for people with mental illnesses where they feel respected, welcomed and supported, so that their illness may have lower impact on their engagement, role ambiguity and productivity level (Villotti et al., 2014). Organizations can also support initiatives such as mindfulness workshops and therapies to reduce stress and anxiety to help leaders deal with job-related stress.

Finally, concerning non-contagious physical conditions, managers must develop workplace interventions to improve pain management and the functional status of workers with musculoskeletal disorders. Initiatives such as these have previously been associated with higher productivity and better job outcomes (van Vilsteren et al., 2015). Additionally, employees should have access to chairs with lower-back support, ergonomic computer keyboards and other work equipment designed to minimize joint pain.

Furthermore, the results of this thesis enhance that managers should pay attention to engagement aspects in robot leadership scenarios. For robot leadership to become a reality in organizations, a collaborative and reliable relationship must be built between social robots and the organizational agents (Samani et al., 2012). In order to achieve greater work engagement, robot leaders should demonstrate transformational leadership characteristics, such as being motivational, inspiring, and able to build confidence and empower their followers (Judge & Piccol, 2004). However, to enhance workers' performance and productivity, robot leadership interventions should place more emphasis on adopting transactional leadership characteristics such as, paying attention to errors, task accomplishment and contingent reward systems (Bass et al., 2003). Specifically, this thesis can be useful to organizations considering adopting social robots in their work environments. Essentially, the main issue is to decide how to implement new technologies (such as social robots) in an organization (Tunç, 2020). The implementation process should be managed by considering psychological and cognitive aspects of human-robot interaction. Several configurations of robots can be programmed in order to maximize the best features of each leadership style, which can be a major advantage of robot leadership since human leaders cannot be programmed in the same way (Watson, 2017).

Finally, this thesis offers an implication related to the implementation of health behavior change interventions using artificial intelligence machines. The application of the HAPA model to human-robot interaction scenarios could enable health-promoting interventions to have substantial reach and potential cost-effectiveness, given its potential to substitute or combine face-to-face sessions with practitioners. That would provide a more efficient way to manage human resources within organizations, without neglecting workers' necessities. Based on the current findings of this thesis, we can recommend practitioners and managers to embrace the use of social robots in work environments. Even if not completely independent and working autonomously, social robots can complement interventions with practitioners (Robinson et al., 2021), contributing to the productivity and vitality of the workforce. Even from a manager or a therapeutic's point of view, social robots may help to reduce workload for humans, while assisting individuals reaching their goals and improve their health and quality of life (Costescu et al., 2014). Moreover, introduce social robots as health promoting agents within workplaces may help managers to deal with presenteeism and absenteeism phenomenon. Since presenteeism is more detrimental for workers already having a poor health status (Dietz et al., 2020b), managers can harness the potential of social robots to develop personalized interventions for each employee and their health status. Those health-promotion interventions must start from centering on leaders' health conditions, since the evidence that leaders' presenteeism can lead to impairments on employees' productivity, work engagement and higher role ambiguity. Engaging in health-promoting programs constitutes a competitive advantage for organizations, especially in a current labor world facing the consequences of the COVID-19 pandemic. Companies can harness the advantages of social robots to help to create a healthy, productive, and resilient workforce, and this thesis provides a solid basis for such interventions.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

This thesis has some limitations that need to be considered when interpreting our results. First of all, when possible, an experimental design approach was performed. The existing literature on presenteeism relies primarily on self-reported measures (Luksyte et al., 2015). To meet the challenges of studying presenteeism in experimental settings, we developed three experimental studies with empirical manipulations to test our hypotheses, seeking in this way to complement the existing literature on presenteeism. Although an experimental design has many strengths, it also has some disadvantages, such as the possibility of human error or the creation of situations that are not realistic. However, our mixed-method approach used in paper 1 (study 2) was selected specifically to help to overcome this limitation. Moreover, all of our data from both paper 1 and paper 2 was collected before the worldwide COVID-19 pandemic. We believe that the effects we found for the contagious condition could be even more evident nowadays. It would be interesting for researchers to analyze the relationship between presenteeism phenomena and contagious diseases in the light of the current COVID-19 pandemic the world is facing. In the same way, data collection for paper 3 and paper 4 were performed during the COVID-19 pandemic lockdowns. We have motives to consider that this affected our research and work plans. We will briefly explain that. Those studies were planned to take place within work environments, i.e., all the interactions were supposed to be face-to-face with the social robot. However, due to the adoption of remote work from the majority of all organizations, this investigation had to be realized in a non-presential context, after several months of delay, since we always believed that it would be possible to conduct the study under the supposed normal conditions. This probably have affected our final sample size, but one should note that we collected data during an unprecedented situation, where we face many challenges in order to conduct the last studies of this thesis. We consider that more workers would be interested in our research if they had the opportunity to interact face-to-face with the robot. In the future, researchers may develop health behavior change interventions with social robots in a presential context, which will surely generate interesting data to report.

Besides this, in paper 2 teams interacted and worked with a robot on one single task. It would be interesting to analyze the impact of robot leadership on organizational outcomes in a longitudinal study. As suggested by some authors (Sebo et al., 2020), perceptions of the relationship with robots tend to evolve over time, in particular concerning trust issues. Thus, future efforts should be made to understand the process of developing a long-term relationship with a robotic leader, while exploring the cognitive and social variables that can influence this relationship.

The last limitation concerning the use of social robots is related to the Wizard-of-Oz method applied. Despite the evident strengths (such as enabling the robot to have a wider range of sophisticated actions in its interactions with the teams), which make it possible to generate significant contributions to the study of robots interacting with teams, it does have some limitations. For instance, some authors considered that Wizard-of-Oz methods make use of social robots more as a proxy for a human and less as an independent entity by itself, holder with full autonomy (Riek, 2012). Accordingly, future studies should focus on autonomous robots that can better simulate how robots will interact with people in non-research environments (Sebo et al., 2020).

A last limitation of this thesis involves the sample of both paper 3 and 4. Since the research' participation was voluntary, perhaps we didn't reach the workers who could actually benefit the most from the intervention (i.e., individuals with higher health-related risk factors). This is a typical example of the barriers to widespread implementation of health promotion programs: the possibility of the insufficient employee interest, especially those who are high-risk employees (Schopp et al., 2014), and more prompt to benefit from the intervention outputs. In the same line, the voluntary nature of this research makes this sample not representative of all employees who may or may not be interested in health behavior change. Upcoming research should focus on performing a similar health-promoting intervention in a larger sample, especially with social robots. This should lead to firm conclusions about changes in health outcomes resulting from long-term interactions with a social robot.

CONCLUSION

A deeply understanding of presenteeism is crucial for developing adequate interventions that could help individuals and organizations deal with this phenomenon. The research reported in this thesis aimed to understand the socio-cognitive aspects related to the impact of leaders' health on subordinates. Furthermore, it was explored the possibility of robot leadership and how social robots can be used in workplaces to promote health behavior change within employees, contributing to the depletion of the presenteeism phenomena. The results of the studies reported in this thesis indicate that leaders can spread a presenteeism climate within their teams, especially through the reduction of employee productivity, work engagement and higher role ambiguity. Furthermore, social robots in leadership roles may be implemented in organizations in order to bring positive organizational outcomes to companies, besides their capability to improve employees' health status through personalized health behavior interventions.

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APPENDICES

APPENDIX A – List of robot agent behavioral change methods, throughout the sessions*.

*Based on Scheerman et al (2020)

Behavior change method	**Description**	**Target construct**	**Example of the agent content**
1) Providing information on health consequences.	Information on the adoption of good health behaviors, making the direct link to the target behavior to adopt.	Outcome Expectancies	The agent provides information about the benefits of good health behaviors (in relation to the target behavior already identified), as well as images or videos that demonstrate the negative consequences of not having these behaviors.
2) Advising to identify reasons for wanting (pros) and not wanting to (cons) change behavior.	Individuals are encouraged to formulate their own pros and cons in changing their behavior.	Outcome Expectancies	The agent helps and guides individuals to formulate the pros and cons.
3) Providing instructions on how to perform the behavior. Demonstrating the behavior: i.e., providing an observable sample of the performance of the behavior (through film) (includes modelling of behavior).	Instructions on and role modelling of effective behaviors.	Self-Efficacy	The agent shows a video demonstrating the correct way to do the target health behavior.

4) Prompting observation of the consequences for others when they perform the behavior (vicarious reinforcement).		Outcome Expectancies, Social Influences	The agent presents information about peers when they performed good health behaviors.
5) Prompting action planning.	Individuals are asked to make concrete plans of when and how they should perform the health behavior, using the if-then formulation.	Action Planning, Intention	The agent advises and disseminate the several forms on which the action plans could be created.
6) Advising to focus on past success.	Individuals are encouraged to focus on their past successful experiences with the target health behavior.	Self-Efficacy	The agent reminds individuals during the sessions to be aware of their high competence in adopting and maintaining their health behavior in the past.
7) Problem solving (i.e. prompting the person to analyse factors influencing the behavior and generating strategies and coping plans to overcome barriers.	Individuals are asked to identify barriers and possible solutions when making coping plans in order to increase adherence to their action plans.	Coping Planning	The agent helps to create a list of critical situations and respective coping plans for each situation.
8) Prompting self-monitoring of behavior and the outcome of the behavior.	Individuals are asked to monitor their health behaviors.	Action Control	The agent provides a digital calendar for individuals to monitor and point out (daily or weekly) the times they practice health behavior.

9) Providing feedback on the outcome of the health behavior.	Specific feedback for each individual regarding the behavior change.	Action control (feedback), Self-efficacy	Weekly, in each session, the agent provides feedback to individuals on their progress and achievements. For example, the agent can provide advice, advise on strategies and praise.
10) Arranging general and practical social support	Co-workers engaged in the intervention are asked to encourage individuals to complete all activities of the intervention.	Social Influences	The agent asks individuals to demonstrate support for their co-workers who are also engaged in the intervention.

APPENDICE B - SCALES USED IN CHAPTER 2 (PAPER 1)

Productivity despite leaders' presenteeism: SPS-6 (Koopman et al., 2002)

Imagine que a imagem apresentada no ecrã representa o líder que o irá acompanhar na sua primeira experiência de estágio na área do seu curso, com quem terá de interagir e ter contacto permanente no local de estágio. Segue-se um conjunto de afirmações sobre a ***sua*** *performance no* ***seu*** *trabalho. Assinale "(1) discordo fortemente" se a afirmação corresponde a uma atitude que você não teria e assinale " (5) concordo fortemente" se a afirmação corresponde a uma atitude que você teria. Assinale "(2) discordo" " (3) não sei" e "(4) concordo" para as restantes afirmações, em função do que lhe parecer mais adequado.*

1. O meu trabalho seria mais complicado de gerir.
2. Conseguiria terminar com sucesso o meu trabalho.
3. Inibir-me-ia de tirar prazer do meu trabalho.
4. Sentir-me-ia desesperado/a na concretização de determinadas tarefas.
5. Conseguiria concentrar-me na concretização dos meus objectivos.
6. Sentir-me-ia com energia suficiente para completar todo o meu trabalho.

Emotional Engagement 6-item scale: Rich et al (2010):

1. Demonstrei entusiasmo pelo meu trabalho.
2. Senti-me energético no meu trabalho.
3. Estive interessado no meu trabalho.
4. Estive orgulhoso do meu trabalho.
5. Senti-me positivo em relação ao meu trabalho.
6. Senti-me animado com o meu trabalho.

Physical Engagement 6-item scale: Rich et al (2010):

1. Trabalhei com intensidade no meu trabalho.
2. Exerci todo o meu esforço no meu trabalho.
3. Dediquei muita energia no meu trabalho.
4. Esforcei-me muito para ter uma boa performance.
5. Procurei o máximo que consegui completar o meu trabalho.
6. Exerci muita energia no meu trabalho.

Role ambiguity (Rizzo et al., 1970):

Durante a tarefa:

1. Soube exatamente aquilo que era esperado de mim.
2. Sei que geri o meu tempo de forma adequada.
3. As instruções sobre aquilo que devia fazer foram claras e objetivas.
4. Tive certezas sobre o nível de autoridade que dispunha.
5. Soube quais eram as minhas responsabilidades.
6. As metas foram planeadas de forma clara e objetiva.

Team performance (Walumbwa & Avolio, 2008):

1. No geral, a minha equipa desempenhou de forma competente o seu trabalho.
2. De acordo com as minhas estimativas, a minha equipa conseguiu completar o trabalho que lhe foi atribuído.
3. A qualidade geral do trabalho desenvolvido pela minha equipa superou as expetativas.

APPENDICE C - SCALES USED IN CHAPTER 3 (PAPER 2)

Human-robot trust (Schaefer et al., 2016):

Indique qual a percentagem % de tempo que o líder/robot EMYS:

1. Agiu consistentemente.
2. Agiu como parte da equipa.
3. Funcionou bem.
4. Funcionou mal.
5. Comunicou de forma clara.
6. Desempenhou a tarefa melhor que um humano faria.
7. Forneceu feedback.
8. Possuiu capacidade de tomada de decisão adequada.
9. Cumpriu as necessidades da tarefa.
10. Forneceu informações apropriadas.
11. Comunicou com as pessoas.
12. Trabalhou bem em equipa.
13. Considerado parte da equipa.
14. Responsável.
15. Solidário.
16. Incompetente.
17. Dependente.
18. Simpático.
19. Confiável.
20. Agradável.
21. Não-responsivo.
22. Autónomo.
23. Previsível.
24. Consciente.
25. Um bom colega de equipa.

Transformational leadership style (Carless et al., 2000):

1. O meu líder comunicou uma visão clara e positiva do futuro.
2. O meu líder tratou os membros da equipa como indivíduos, suportou e encorajou o desenvolvimento.
3. O meu líder encorajou e reconheceu os membros da equipa.
4. O meu líder promoveu a confiança, envolvimento e cooperação da equipa.
5. O meu líder encorajou a pensar os problemas de novas formas.
6. O meu líder foi claro sobre os seus valores e agiu de acordo.
7. O meu líder incutiu orgulho e respeito nos outros e inspirou-me para ser altamente competente.

Transactional leadership style (Carless et al., 2000):

1. Deu-me apoio em troca dos meus esforços.
2. Discutiu quem era o responsável por atingir metas específicas de desempenho.
3. Tornou claro aquilo que cada um podia esperar receber quando os objetivos de desempenho foram atingidos.
4. Exprimiu satisfação quando fui ao encontro dos desempenhos esperados.
5. Focou a atenção em irregularidades, erros, exceções e desvios das regras.
6. Concentrou a sua total atenção em lidar com erros, queixas e falhas.
7. Manteve-se a par de todos os erros.
8. Dirigiu a minha atenção para as falhas face aos desempenhos esperados.

APPENDICE D - SCALES USED IN CHAPTER 4 (PAPER 3)

Godspeed Questionnaire (Bartneck et al., 2009):

Por favor, avalie a sua impressão sobre as caraterísticas humanas do robô EMYS nas seguintes escalas:

- Falso/ Natural
- Com aspeto mecânico / Com aspeto humano
- Inconsciente / Consciente
- Artificial / Realista
- Move-se com rigidez / Move-se com fluidez
- Morto / Com vida
- Parado / Enérgico
- Mecânico / Orgânico
- Estático / Interativo
- Apático / Participativo
- Não gosto do robot / Gosto do robot
- Hostil / Amigável
- Antipático / Gentil
- Desagradável / Agradável
- Horrível / Simpático
- Incompetente / Competente
- Ignorante / Sabedor
- Irresponsável / Responsável
- Pouco Inteligente / Inteligente
- Insensato / Sensato
- Ansioso / Descontraído
- Calmo / Agitado
- Sereno / Surpreendido

Patient Engagement in Research Scale (PEIRS):

Pense agora sobre a sua experiência em ter feito parte deste estudo. Por favor, indique o seu grau de concordância com cada uma das seguintes afirmações:

1. Tive interesse na temática da investigação.
2. Percebi os objetivos da investigação.
3. Concordei com o objetivo da investigação.
4. Recebi informações suficientes acerca da investigação.
5. A comunicação com a equipa de investigação foi clara durante o tempo que durou o estudo.

6. A investigação valeu a pena o tempo que investi nela.
7. Tive oportunidade de dar o meu contributo para a escolha das minhas tarefas para o estudo.
8. As minhas preferências (tais como hora, duração, local e formato) foram consideradas na marcação das sessões.
9. Ao longo do da investigação, tive tempo suficiente para completar as minhas tarefas para o estudo.
10. Tive oportunidades para expressar os meus pontos de vista.
11. Gostei de fazer parte da investigação.
12. Tive um impacto nas decisões da investigação.
13. Vi como as minhas contribuições podem beneficiar outras pessoas.
14. O meu envolvimento neste projecto teve um impacto positivo na minha vida.

Construtos HAPA (Renner & Schwarzer, 2005):

Intention:

Quais são as suas intenções para as próximas semanas e meses? Tenciono…

1. Viver uma vida mais saudável.
2. Comer o mais saudável possível.
3. Comer a menor quantidade de gordura possível
4. Parar de fumar.
5. Beber menos álcool.
6. Fazer exercício físico regularmente.
7. Perder peso.

Outcome Expectancies (example for physical activity condition):

Quais pensa que serão as consequências de praticar exercício físico regularmente? Se eu praticar exercício físico regularmente:

1. Sentir-me-ei simplesmente melhor depois.
2. Não terei problemas de peso (nunca mais).
3. Terei de fazer maior esforço de cada vez.
4. As outras pessoas irão apreciar a minha força de vontade.

5. O meu nível de colesterol irá melhorar.
6. Irei parecer mais atrativa/o.
7. Irei estar mais equilibrada/o na minha vida diária.
8. Irá significar um aumento da minha qualidade de vida.
9. Terei de despender mais tempo de cada vez.
10. Serei apreciado pelos outros por fazer isso.
11. Será um encargo para a minha situação financeira.
12. Irei prevenir um ataque cardíaco.
13. Será bom para a minha pressão sanguínea.

Self-efficacy (example for physical activity condition):

Certos obstáculos dificultam o início da prática de exercício físico. Quão certo está de que pode começar a praticar exercício físico regularmente? Tenho a certeza de que:

1. Consigo mudar para um estilo de vida mais ativo.
2. Consigo ser fisicamente ativa/o pelo menos uma vez por semana.
3. Consigo ser fisicamente ativa/o pelo menos três vezes por semana, por 30 minutos de cada vez.

Risk perception:

Quão provável é que você tenha em algum momento na sua vida:

1. Colesterol elevado?
2. Ataque cardíaco?
3. Tensão arterial elevada?
4. Enfarte?
5. Doença cardiovascular?

Action Planning (example for physical activity condition):

Já tem planos concretos no que respeita ao exercício físico? Eu já tenho planos concretos:

1. Quando fazer exercício físico.
2. Onde fazer exercício físico.
3. Como fazer exercício físico
4. Quantas vezes fazer exercício físico.
5. Com quem fazer exercício físico.

Coping Planning:

Tem planos concretos para a prática de exercício físico (criação de hábitos)? Eu já tenho planos concretos:

1. O que fazer se algo intervir nos meus planos.
2. O que fazer se falhar uma sessão.
3. O que fazer em situações complicadas de forma a manter com as minhas intenções.
4. Quando ficar especialmente atenta/o de modo a manter o meu compromisso.

APPENDICE E - SCALES USED IN CHAPTER 5 (PAPER 4)

Versão portuguesa da escala Warwick Edinburgh Mental Well-being Scale (Tennant et al., 2007):

1. Tenho-me sentido otimista em relação ao futuro.
2. Tenho-me sentido útil.
3. Tenho-me sentido relaxado.
4. Tenho-me sentido interessado pelas outras pessoas.
5. Tenho tido energia de sobra.
6. Tenho lidado bem com os problemas.
7. Tenho conseguido pensar de forma clara.
8. Tenho-me sentido bem comigo mesmo.
9. Tenho-me sentido próximo de outras pessoas.
10. Tenho-me sentido confiante.
11. Tenho sido capaz de construir as minhas opiniões sobre as coisas.
12. Tenho-me sentido amado.
13. Tenho-me sentido interessado com coisas novas.
14. Tenho-me sentido alegre.